ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

INGENIERO INDUSTRIAL

FLOW CHARACTERISATION IN THE OPEN TEST SECTION OF A GÖTTINGER-TYPE WINDTUNNEL

Autor: Jesús Lorenzo Areses

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Karlsruhe

July 2018

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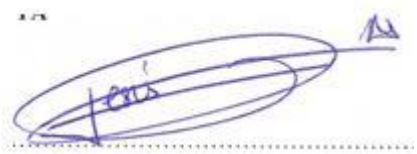

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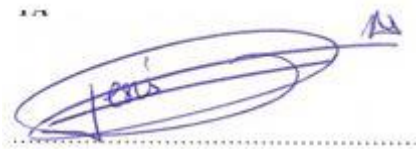

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CARACTERIZACIÓN DEL FLUJO EN LA SECCIÓN ABIERTA DE ENSAYO DE UN TÚNEL DE VIENTO DE TIPO GÖTTINGER

Autor: Jesús Lorenzo Areses.

Director: Jochen Kriegseis.

Entidades colaboradoras: Karslruhe Institut für Technologie, Universidad Pontificia de Comillas.

RESUMEN DEL PROYECTO

INTRODUCCIÓN

El túnel de viento del Instituto de Mecánica de Fluidos (ISTM) se encuentra actualmente en fase de revisión para mejorar tanto la velocidad máxima del flujo como su calidad. Antes del proceso de revisión, se realizaron varias mediciones de flujo para documentar la situación de este. Desde esta última revisión, el túnel cuenta con un nuevo motor, nuevas pantallas, una boquilla completamente nueva y un diseño modificado del difusor. El diámetro hidráulico del nuevo tramo de prueba es de 1,60 m a una velocidad máxima de 57 m/s. Como primera prueba, se ha registrado la distribución de la presión estática a lo largo del eje del chorro para verificar la homogeneidad mejorada de la variable de estado en la sección de prueba abierta. Todas las demás propiedades de flujo aún no han sido evaluadas. En particular, una caracterización apropiada del chorro libre propagándose a lo largo de la sección de prueba es de suma importancia. Para ello se definirá la región central (no perturbada) del chorro que nos mostrará la zona útil para el ensayo del túnel.

CONTENIDO

El trabajo de la presente tesis de licenciatura gira en torno a la identificación y caracterización de la región núcleo antes mencionada a través de las posibles velocidades de túnel. El primer y principal paquete de trabajo se refiere a la determinación de la región central por medio de datos experimentales de presión. Una vez determinada esta para las tres velocidades de ensayo se mostrará si la velocidad es un factor de dependencia de la misma y los errores que esta solución puede llegar a tener explicando las razones de los mismos.

METODOLOGÍA

Para llevar a cabo esta caracterización del flujo, debemos llevar a cabo una solución experimental en la que mediante mediciones en el tramo de prueba podamos mostrar el perfil de velocidad del flujo y así sacar las conclusiones necesarias. Para lograrlo, llevamos a cabo un proceso de tres pasos, estos son:

- En primer lugar, la construcción de las herramientas para poder realizar todas las medidas necesarias en el periodo de tiempo en el que el túnel de viento esté disponible para su puesta en marcha.

- En segundo lugar, se toman las medidas con las herramientas construidas en el proceso anterior y utilizando las diferentes máquinas disponibles en el laboratorio del departamento de ISTM.

- Finalmente, la caracterización del flujo a través de representaciones teóricas y prácticas del resultado de las mediciones. Todos ellos seguidos de sus correspondientes conclusiones.

CONCLUSIÓN

Tras desarrollar este proyecto se puede afirmar que los resultados de este son acordes con la teoría aplicada, todas las irregularidades tienen su explicación pertinente y lógica. Los ensayos realizados muestran un comportamiento similar entre sí a pesar de las posibles dificultades que se pueden manifestar. Por esta razón se puede afirmar que este túnel de viento tiene una parte principal de flujo amplia, definida, y de dimensiones normales para todas las velocidades de ensayo posibles.

FLOW CHARACTERISATION IN THE OPEN TEST SECTION OF A GÖTTINGER-TYPE WINDTUNNEL

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Director: Jochen Kriegseis.

Collaborating Entity: Karslruhe Institut für Technologie, Universidad Pontificia de Comillas.

PROJECT OVERVIEW

INTRODUCTION

The big wind tunnel at the Institute of Fluid Mechanics (ISTM) is currently under revision in order to improve both maximum flow speed and its quality. Prior to the revision process, various flow measurements were conducted in it to document the reference situation. Since then, the revision comprised a new engine, new screens, and entirely new nozzle and modified diffusor design. The hydraulic diameter of the new test section is 1,60m at a maximum speed of 57m/s. As a first test, the static pressure distribution along the jet axis has been recorded to verify the improved state-variable homogeneity in the open test section. All other flow properties remain yet to be evaluated. Particularly, a proper characterization of the free jet as propagating along the test section is of utmost importance, since the (undisturbed) core region of the jet defines the test location during tunnel operation.

CONTENT

The work of this thesis is about the identification and characterization of the core region through the possible tunnel speeds. The first and main work package refers to the determination of the central region by means of experimental pressure data. Once this is determined for the three test speeds it will be shown if the speed is a factor of dependence of the same and the error that this solution can have explaining the reasons for them.

METODOLOGY

In order to carry out this flow characterization, we must carry out an experimental solution in which by means of measurements in the test section we can show the velocity profile of the flow and thus draw the necessary conclusions. In order to attain this, we carry out a three-step process, these are:

- First of all, the construction of the necessary tools to be able to make all the necessary measures in the period of time in which the wind tunnel is available to start up.

- Secondly, taking the measurements with the tools built in the previous process and using the different machines available in the laboratory of the ISTM department.

- Finally, the characterization of the flow through theoretical and practical representations of the measurements' result. All of them followed by their corresponding conclusions.

CONCLUSION

After developing this project, it can be said that the results of it are in accordance with the applied theory, all the irregularities have their pertinent and logical explanation. The tests carried out show a similar behaviour to each other despite the possible difficulties that may arise. For this reason, we can say that this wind tunnel has a main part with a wide, defined flow and normal dimensions for all possible test speeds.

ACKNOWLEDGEMENTS

In the development of this project, I must highlight the help and support of many people who had help to successfully completed it. In the field of work, I had always found a group very willing to help, Sebastian Banz, Sebastian Reimann, all the workers who are in the laboratory and of course my tutor and guide Jochen Kriegseis. On the other hand, outside the development of the project itself, I would like to include in my thanks to my family, my friends of Erasmus, Ignacio Olalquiaga Varela and all those people who have supported me and supported me in the moments when it seemed that nothing was going on. Also, to my friends Jaime Machés and María José Bascuñana for guiding me through the guidelines for writing this project.

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REPORT INDEX

REPORT

INTRODUCTION

INTRODUCTION:

The Göttinger wind tunnel of the ISTM department of the Karlsruhe Institute for Technology is in the process of being repaired. This repair, which includes: the new engine, a new diffuser, a new hydraulic diameter… After this, the tunnel has not been followed by an analysis of the flow in the open section. This means that the state of the most important part of the tube flow, the test section, remains unknown. This is the main reason for the development of the project.

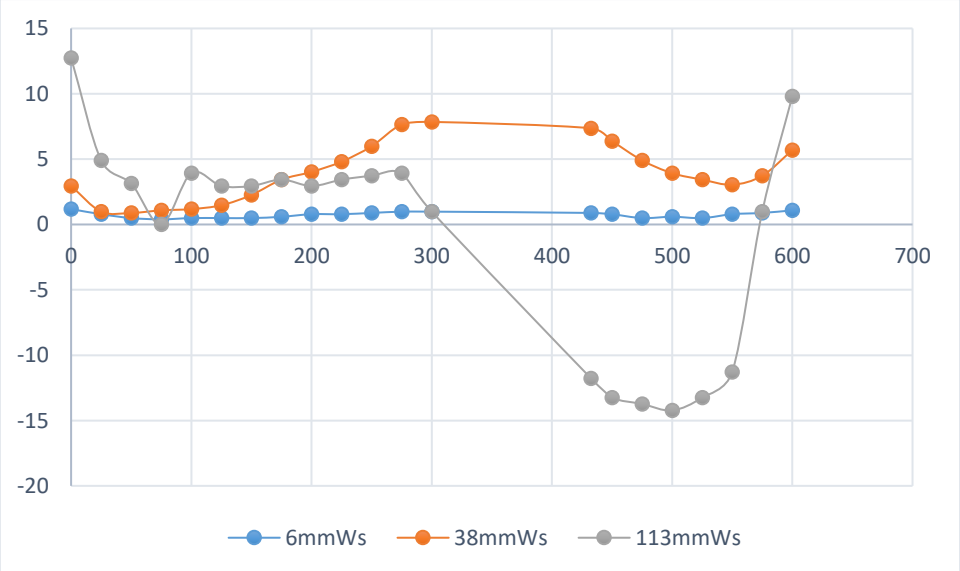
This study is divided into three main parts. Firstly, the construction of the tools used to measure the pressures necessary for a correct flow characterisation in the test area. Secondly, the taking of measurements by making joint use of these tools together with the measuring machines in the laboratory. And finally, a result obtained from the analysis of the velocity profile at each point along the section with the definition of a core part region for the wind tunnel.

BACKGROUND:

Prior to the work carried out on this project, a similar study of the tunnel flow has been carried out. This will guide us in verifying the validity of our results. In this study, the static pressure in the central part was measured for all points along the test section. The measurements have been taken with the Betz Manometer that has been used in this project connected to a tool similar to the one used later for static pressure measurement. The meter gives us the total pressure. The dynamic part ($\frac{h}{2}\ u^2$) is converted into $\rho * h * g$ inside the manometer and displayed accordingly with the glass scale inside. Henceforth with a water column height measurement, the static pressure can be obtained using the formula shown below.

$$Pest[Pa] = \rho * h * g$$

Considering that the fluid is air ($\rho = 1.28 kg/m^3$) and the atmosphere of the earth *(g=9.8m/s).* The results shown in the following graphic are obtained:



Graph 1.Background Measurements [1].

These measures have been taken at three speeds similar to those tested in this project (*9.94 , 25 and 43.1m/s*). They will serve as a guide and reference, although they do not necessarily have to resemble the measures tested subsequently. The measures, shown in "Appendix Tables'', have been taken prior to the repair of the tunnel while the measures to be carried out in this project are subsequent to this one.

MOTIVATION:

The main professional motivation of this project is the improvement of the flow in the wind tunnel of the ISTM (Institute of fluid mechanics) laboratory. A characterization is sought, so it will lead to future changes or arrangements in the tunnel structure. It is a continuous project, the reason why this characterization is not the first nor will it be the last, since this wind tunnel is constantly undergoing improvement projects.

On the other hand, the reasons that make this project more attractive and impel to choose it. These reasons may be grouped in two: the engineering area where we were working and the way we worked. To develop the first reason, let be known that this project deals with topics of fluid mechanics, very attractive to someone who has an interest in this area. What better way to go into this topic than with a large wind tunnel at a university like KIT (Karlsruhe Institute for Technology)? In addition, in this laboratory.

In relation to the method, which compels the second reason, the fact that this project work is very practical is something that would motivate many students. In There is no better way to learn than to put into practice all the theory that has been studied. Making mistakes again and again in practice as is how the subject matter is really mastered.

OBJECTIVES:

The main objective of this project is to know the width and length of the effective test section of this wind tunnel by characterizing of them in different situations. This means to determine the zones of the test area where the fluid velocity is uniform and can be considered an effective test area. In order to reach this final objective, other smaller objectives have to be reached, these are:

-Construction of an effective pressure meter suitable for the size of the tunnel: Due to the reduced time available for taking measurements, it is necessary to construct a series of tools that, connected to different laboratory machines, take the necessary measurements for subsequent characterization.

-Measurements' making: It consists on obtaining all the necessary measures for the characterisation of the flow in the time the wind tunnel is available (close to 8 days).

-Analysis of the results obtained in the previous section: the elaboration of an illustration showing the areas where the flow is uniform, and the explanations of the different results obtained, as well as a subsequent reflection on them taking care about the relation between the expected theoretical result, the practical result and its uncertainties.

STATE OF ART

A wind tunnel is a tool used to analyse the aerodynamic efficiency of a body. The principle of operation of this is based on the fact that the fluid (air) is blown or sucked through an air duct with a test section where the objects to be studied are placed. The most common variables handled by this tool are pressure, speed, lift, drag forces, etc. To measure all these variables, Pitot tubes (pressure), hot-wire anemometers, Doppler laser or PIV (speeds), aerodynamic scales (forces), smoke-like tracer particles (visualization of flow), etc. are commonly used. Wind tunnels can have a wide variety of sizes, all depending on the size of the bodies to be tested. There are sizes that can accommodate an aircraft inside and others with micron-scale measurements.

-History of wind tunnel:

British military engineer Benjamin Robin (1707-1751) invented a rotating arm that would serve as a test tool for aviation. Thus, was born the first tool that would aim the same objective as the wind tunnel, to make aerodynamic tests. Later, George Caley (1773-1857) improved the Benjamin Robin prototype by building a five-foot-long arm that achieved a top speed of between ten and twenty feet per second. With the tests performed on this tool, Caley was able to create a small glider that is believed to be one of the first heavy air vehicles ever carried by a human. However, the arm system did not offer a realistic test. The air forces of incidence were not of normal incidence and were in turn affected by centrifugal forces.

With these factors in mind, a member of the Board of the British Aeronautical Society, Francis Herbert Wenhan (1824-1908), solved these problems by designing and operating the first wind tunnel in 1871. Previously a wind tunnel known as an "aerodynamic tube" was designed by Ziolkovsky in 1897. Wenham then extracted the technical data and developed his project.

In the wind tunnel, many scientists have carried out important tests for the advancement of science. In 1897, Carl Rickard Nyberg used the wind tunnel to design his Flugan. The Englishman Osborne Reynolds (1842-1912), of the University of Manchester, demonstrated that the pattern of airflow over a scale model would be the same for the actual vehicle if a certain flow parameter were the same in both cases. This factor is the now known Reynolds Number.

The Wright brothers, before achieving their Flyer prototype in 1906, conducted several trials with gliders and models in wind tunnels. In these tests, they determined the wing profiles, studied models of Otto Liliental, etc. This particular tunnel was homemade but enough to determine the profiles for the lift.

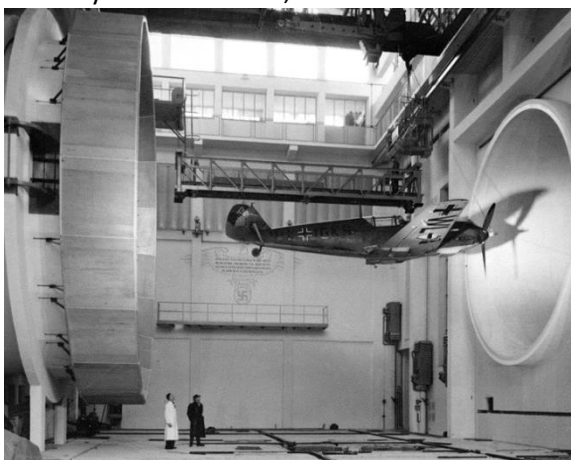


Figure 1.Adlershof wind tunnel. Berlin 1932-1934. [19]

Another very famous wind tunnel was the one used by German scientists during the Second World War in Peenemünde. It is a very particular case as increased natural caves were used with the excavation sealed to store large volumes of air that could be redirected through the tunnels. This allowed research into high-speed regimes that were key to German aeronautical engineering, making it the first country to put jet fighters into service. Also, in Germany, the first supersonic tunnel with a power of 1000,000 horsepower was built. This was dismantled

after the Second World War and moved to America. Another very important tunnel for war plain test was built in Berlin (1932-1934) in Adlershof where is located the German Aviation Research Institute. Today the world's largest wind tunnel is owned by NASA and is located at the California Institute NAFC. [2]

-Parts of the wind tunnel:

The most general parts of a wind tunnel are:

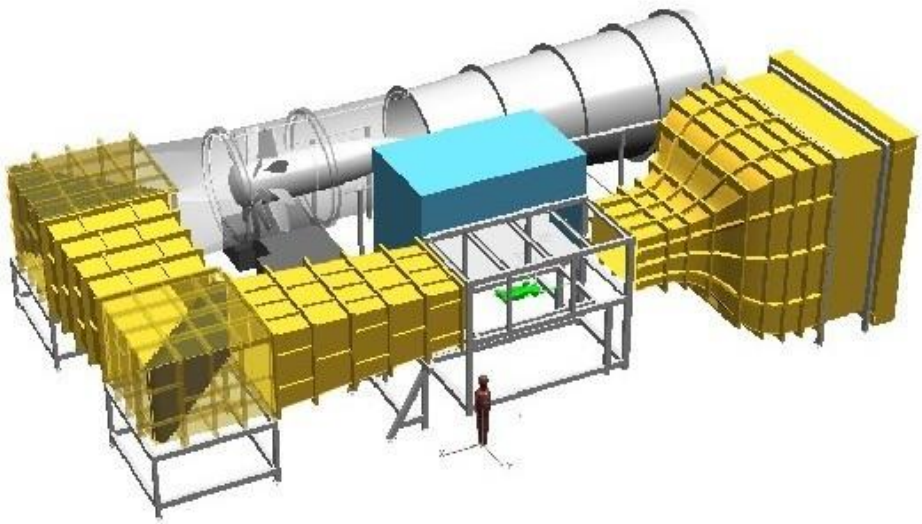


Figure 2. Wind tunnel illustration [3].

1.Test chamber:

The test chamber is the place where the element to be tested will be placed. It should have as uniform flow as possible. It should be long and wide enough to accommodate the elements expected in your tests and not have to be placed at the beginning of the test, where the flow is slightly irregular. Because the boundary layer increases along the length of the test chamber, a smaller effective area than the test chamber is created. To reduce this effect, it is recommended to add a slight angle of convergence on the walls. The length of the test chamber varies between one and two times the larger dimension of the section. The test chamber usually consists of transparent walls, with or without enough windows for correct observation.

2.Shrinkage:

Shrinkage aims to reduce turbulence, reduce the thickness of the boundary layer and accelerate the fluid. At the inlet and outlet of the shrinkage, there is an adverse pressure gradient that can cause the boundary layer of the wall to dislodge and decrease the quality of the flow. It should be noted that the corners of the shrinkage can also alter the flow and are therefore bevelled.

3.Remaining chamber and turbulence manipulation devices:

This is a zone of a constant area that is located before the contraction and reduces the turbulence scale of the tests. This is achieved by means of bee panels and meshes on a perforated plate. This panel eliminates velocity components perpendicular to the main flow direction. The mesh is placed after the bee panel and removes the remaining turbulence.

4.Diffuser:

The objective of this part of the tunnel is to reduce the speed by expanding the fluid and recovering the static pressure. The reason for the need for a diffuser is that the variation in losses is proportional to the velocity cube. The diffusers are very sensitive to design errors, can create boundary layer separation, cause tunnel vibration, fan oscillation or speed variation in the test area. The optimization of the design of this part of the tunnel is the most important. It is best to increase the area as much as possible without detachment of the boundary layer.

5.Curves and elbows:

The function of these is to change the direction of flow. They can be equipped with current straighteners to prevent the flow from falling off the inner wall due to centrifugal acceleration.

6.Ventilator:

Located after the test chamber. They are responsible for circulating the air through the tunnel at a certain speed [4].

-<u>Wind tunnel types:</u>

There are tunnels of different sizes and types. These are classified according to the air circulation inside and the speed of the air. Once classified by these two criteria the size will depend on the elements to be evaluated in the tunnel. Depending on the air circulation inside, there are open and closed tunnels.

The open tunnels are the ones that take the air from the atmosphere and after passing it through the test chamber return it to the atmosphere again. Closed tunnels are those in which the air circulates several times through the chamber, recovering its fluid energy by means of a diffuser, before reaching the diffuser area again.

Depending on the speed of the fluid we can find four types of wind tunnels: Subsonic, Transonic, Supersonic and Hypersonic. These are differentiated by a characteristic number called the Mach number. This number is a measure of relative velocity defined as the ratio of the velocity of an object to the velocity of sound in the medium in which the object moves. It is expressed according to the equation:

$$M = \frac{V}{V_s} \quad [5]$$

$$(V_s, sound\ velocity\ in\ the\ fluid)$$

The consequence of different speed types (and therefore different Mach numbers) means that this classification also generally changes the motor type, section, flow type and compression ratio as shown in the table below:

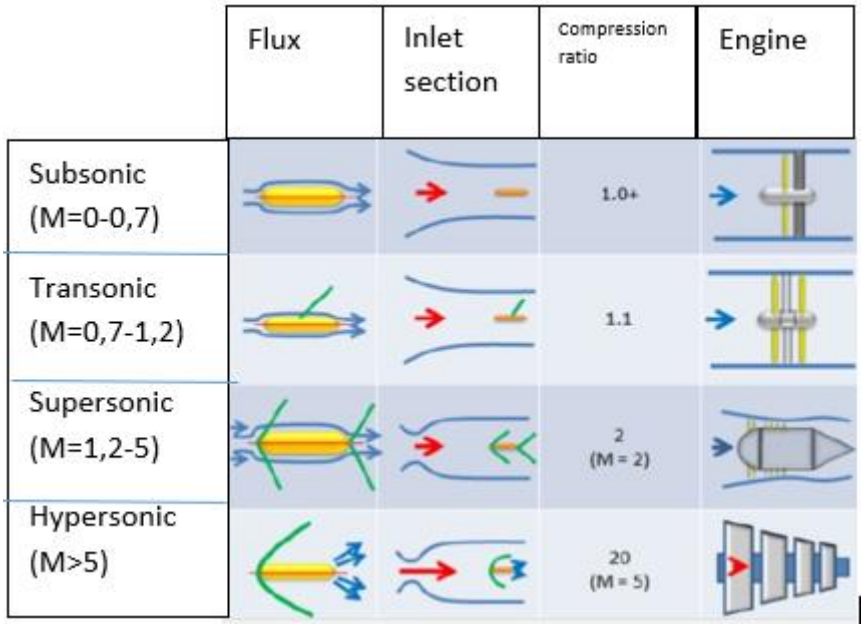


Figure 3. Mach Table [5].

The case of the ISTM wind tunnel is a subsonic wind tunnel with nozzle dimensions of 1. 4 x 1. 8 m. The distance of the test section is 7 m. It is located in the laboratory of the ISTM.

Figure 4.Wind tunnel nozzle and diffuser [6].

In this project objective is looking to characterize the flow of the same, so we will have to define a characteristic that indicates the quality of a flow within the wind tunnel. A wind tunnel will work best the more effective flow area it has to perform tests within the test section. When the flow is measured, it refers to the flow that has not acquired any turbulent character, has not been mixed and has not slowed down and has the same speed as the one marked by the tunnel in its operation. This section where this flow is found is defined in jet theory as the core part.

-Core part of a subsonic jet theory:

The flow of a jet pass through three different phases in its path. These have different characteristics and are defined as:

-Potential core: First part of the fluid path in which two layers with different properties are distinguished. On the one hand, there is the Core part and on the other the mixed layer.

- Transition section: Part of the flow where only the mixing layer is distinguished (starts at the end of the Core part) but no regular velocity profile is yet defined.

- Fully-developed part: The last phase of the fluid in which a clear velocity profile can be distinguished. [7]

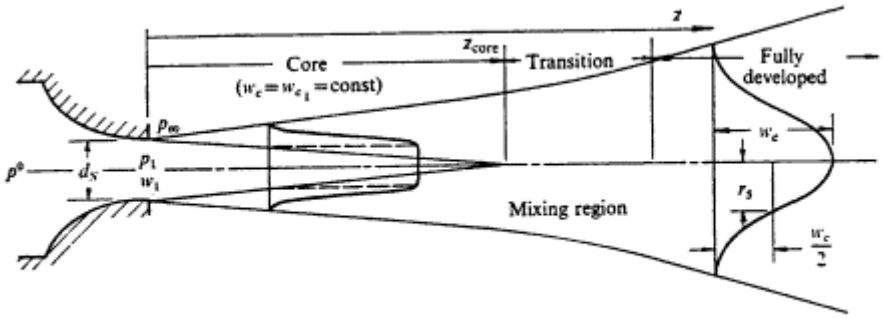


Figure 5. Jet fluid phases illustration. [7]

In the Göttinger wind tunnel, our fluid is interrupted in the last two phases by the entry back into them. For the interest of the project, we will only develop a little more detail in the first phase. This is characterized by the fact that as the fluid penetrates the atmosphere a layer of mixture will be produced whit a define thickness δ. This thickness will become larger as the distance to the flow outlet increases. This mixed layer is bounded by the Jet boundary layer.

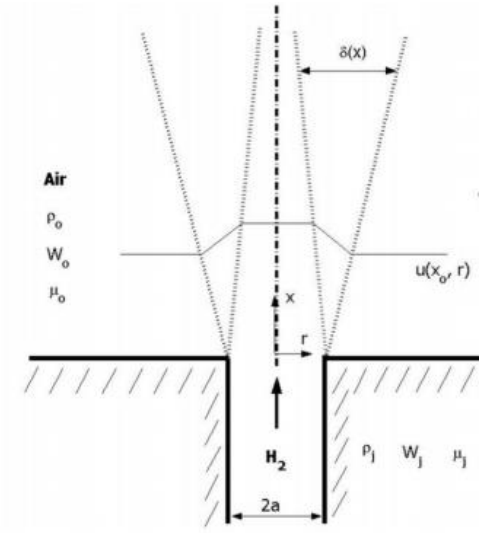


Figure 6. Potential core [8].

By comparing the longitudinal convection term of the movement quantity equation at a greater axial distance, the velocity will be reduced by values of the order of itself due to viscosity effects. The evolution of the growth of the mixing layer as a function of the axial distance will be approximate [8]:

$$\delta \sim \sqrt{\frac{\mho_j}{U_{jx}}} \qquad (7) \quad [8]$$

($\mho_j$: dinamic viscosity of the fluid/ U_{jx}:fluid velocity in at a distance x)

As we can see from the formula the size of this layer is inversely proportional to the velocity of the fluid, therefore, as we move away from the flow outlet it will be larger.

In the central part of this mixing layer, exist a region called the Core Part which is the part of the flow with a similar velocity that has not been mixed when leaving the wind tunnel. This region is the one we are looking for in this project, to determine the part of the test section where the flow has the same velocity and is in a purer state and where experiments can be done.

ASSIGNMENTS

The tasks to be carried out in this project are three. These are explained below in the order of execution. They have been carried out in a period of approximately five months, these are:

1.CONSTRUCTION:

-Construction objectives:

Construction of a multi-point total pressure gauge and a static pressure point.

-Previous design requirements:

To carry out this project, a pressure gauge has been built so that it can give a horizontal measurement of the different points of the section where the flow takes place. This tool will be connected to the measuring station that will measure the pressures at each point. This structure had to meet several requirements:

Firstly, this tool had to be able to take several pressure measurements simultaneously. The availability of time to take measurements in the wind tunnel was reduced to eight days (approximately). Therefore, it was necessary to be able to characterize all pressures at a certain distance and height from the flow outlet in each measurement. This statement leads us to know the second requirement of the design. The tool must have two degrees of freedom: First, the height of the measurements, which must be adjustable. And secondly, the distance to the flow outlet point. The pressure gauge should move easily on the laboratory floor so that any change in the distance of the measurements would not be a waste of time. Finally, this tool must be suitable for the measurement environment. It must be able to withstand airflows of up to 57 m/s without compromising the accuracy of the measurements. For all these reasons, several design decisions have been made during construction and will be discussed below.

-Construction:

At first, due to experiments previously carried out in the laboratory, a steel bar with twenty-four measuring points was available. All these points are characterized by a tube that passes through the steel giving an entry and exit point to take the measurements. Also, at its ends were two plates with four holes that gave the possibility of a bolted joint. With this tool, it could largely meet the requirements of the first design point. On the other hand, it has two tripods with wheels and an adjustable height that could be used to hold the same bar and meet the requirements of the second design point.

The first task that was presented is the union of these pieces to form the main structure of the tool. First step is to screw two metal bars perpendicularly onto the tripods. These metal bars were available to laboratory workers for the easy construction of structures, as they have tracks where different bolted elements can be placed as shown in figure 7.

Figure 7. Tripod with tracks [6].

After this step, it was concluded that there was a need for a connecting element between the bar fasteners and the bars placed on the tripods. The materials laboratory was then commissioned to provide two square metal plates to connect the vertically positioned bar to the measuring bar. These plates have two holes located in a vertical line, which will serve to attach them to the tripods. There are also four holes in each corner of the plate for fastening the measuring rod.

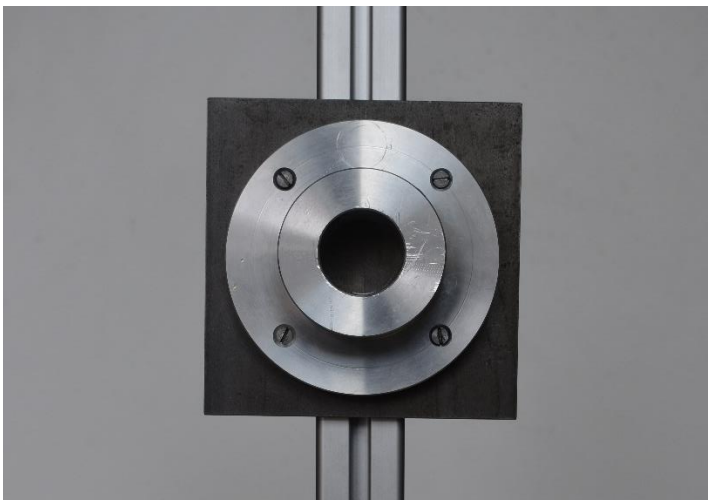


Figure 8. Plate connected to the tracks and to the measuring rod clamping element [6].

Once the tool skeleton was built, the next step to be dealt with was the connection of this tool to the measuring station. Because of this, some fasteners were welded to the outlets of the measuring points in order to be able to connect plastic tubes to them, which will later serve as a connection to the machine. This welding was first attempted with an AS100 silicone gun, but due to its low resistance and the future exposure of the machine to strong fluid currents it was decided to change the welding to an electric tin soldering iron JBC 14ST.

Figure 9. Welded outlet tubes Tool 1 [6].

Once the outlets of each measuring point have been welded, we cut the tubes to different sizes (depending on the distance from the measuring point to the machine). These tubes go from the outlet of each point on the measuring rod to the machine's inlet points.

After the entire casing of the machine had been worked out, the problem of the trajectory of the tubes to the machine arose again. Due to the strong air flow in the evaluation section, during the measures the tool cannot leave the tubes loose at the mercy of air movement. Therefore, and to give it a more aerodynamic shape, an aluminium plate was ordered that will work as a wing. This board will have two main functions. The first and most logical is to give the tool the aerodynamic shape and to do not interrupt the flow as much as possible. The second function is to cover the path of the tubes inside so that they are not exposed to air currents. For the placement of this plate, the measurements of the measuring rod and the distances between the tubes of the measuring rod were taken. The piece was folded as a custom-made wing in the laboratory so that it did not require any adhesive. The finished set of this tool will be called Tool 1.

Figure 10. Aluminium plate. [6]

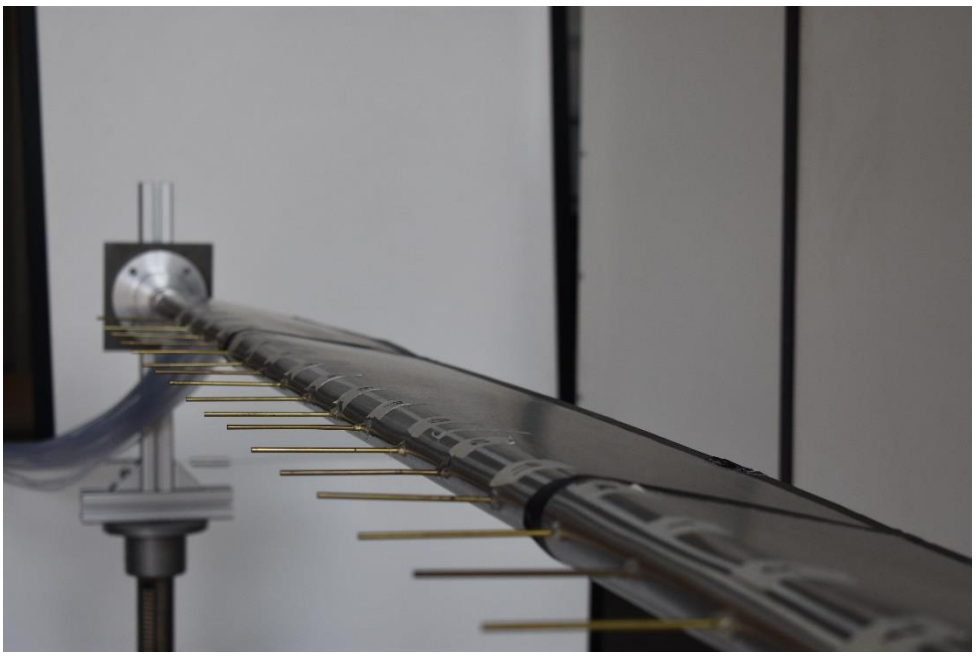


Figure 11. Tool 1 (built) [6].

Once the tool was built, to take accurate and centred measurements of the distance from the flow outlet, the construction of a floor scale that would meet these two requirements was concluded. The scale is constructed with two long wooden beams bolted to the floor in a

position that limits the wheels of the tool tripods to be centred in reference to the air outlet. On this scale is marked on each side a measurement in meters from zero to seven every 0. 25 meters (distances at which we will take the measurements).

In order to measure the static pressure, the first step we made was to place a Prandtl tube held in place by a clamp in the middle of the bar. This measuring system could not withstand the strong flows and vibrations, therefore, a new way of measuring static pressure had to be developed. For this purpose, one of the tripods used in the measuring tool was used and a Prandtl tube was placed at the top. This tube is fixed to the perpendicularly positioned bars by means of bolted joints. This second tool is placed in every measure in the centre line and is called Tool 2.

2.MEASUREMENT:

-Prior to taking measurements:

Before taking measurements in the wind tunnel, is important to ensure that the use of the wind tunnel during this test phase will not affect its operation. If this is not fulfilled, the meaning of the project itself would be completely lost, since if the evaluation of the project were to produce damage it would not be a correct evaluation. The day before the measurement week, the wind tunnel must be cleaned inside. This has also been used to clear elements from the laboratory that can be sucked in by the tube itself. In order to ensure that this does not happen under any circumstances, a protective net must be installed at the flow inlet of the test zone.

A wind tunnel ignition protocol shall also be applied before the daily measurements are carried out. This basically consists of following a few steps to prevent risks, these are:

- Emptying of the evaluation area of possible suctioned elements.

- The closing of the laboratory doors and placement of the corresponding signs indicating the operation of the tunnel.

- Check that no one is inside the tunnel and that the access door to the tunnel is closed.

- Indicate the time, day, purpose and person in charge of using the tunnel at that time on the tunnel notebook.

- Turn on the tunnel.

-Taking measurements:

In the measurement of this project, the measurements of total pressure and static pressure can be distinguished. These differ both in the measuring tool and in the machine that gives us the results. We will also evaluate the tunnel at three different flow rates. The first at 10 m/s, the second at 25 m/s and the last at 45 m/s.

There are two measuring machines and tools used in this experiment:

-Measure station and Tool 1: Total pressure.

This machine is a measuring station where it can measure more than 50 measurements through its inputs on the back of the machine. This machine measures one by one the pressure of its inputs comparing it with another reference pressure connected to Sentra ACUSense sensors (P/N: ASL12R5WDFF2B03A00). In the case of this project, as the objective of this machine is to obtain the total pressure, the reference point will be at ambient pressure.

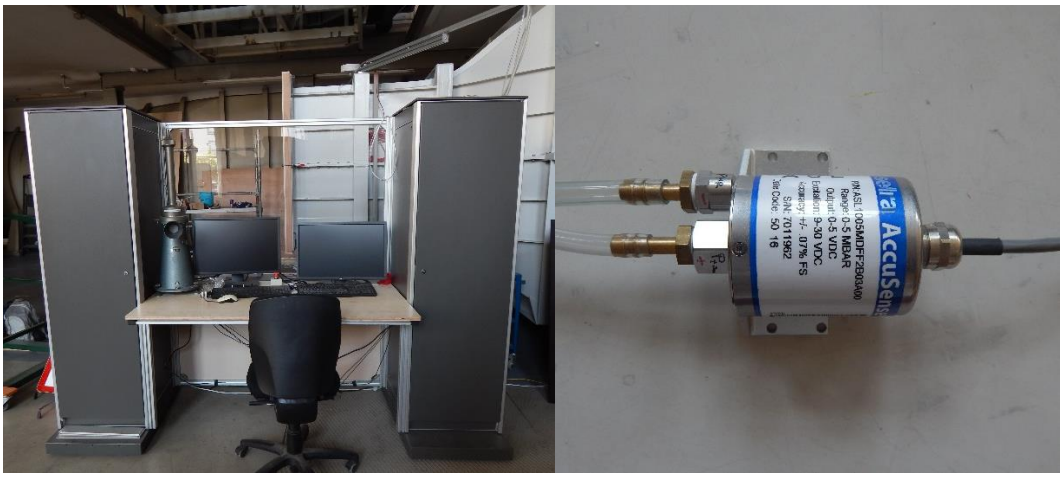


Figure 12. Measuring station and pressure sensor [6].

For the total pressure measurements, we have used the tool mentioned as Tool 1. We will place the tool at the zero-measuring point at medium height (in the middle of the flow outlet) and as the measurements are finished at one point we will move it 0. 25 m to the next mark on the scale. We will carry out this procedure for all three test speeds. An important aspect that has slowed down the measurements is the impossibility of moving the tool with the tunnel in operation at speeds of 25 and 45 meters per second. At these speeds, it has been necessary to slow down the tunnel as it can be dangerous to be in the test area.

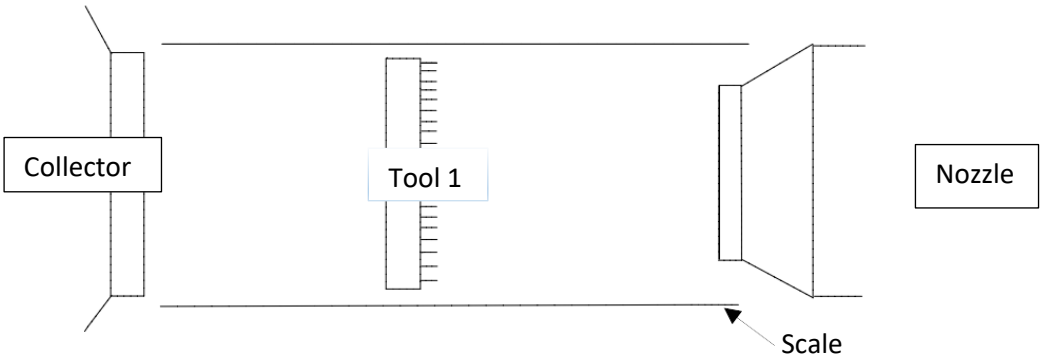


Figure 13. Tool One Position.

-Betz manometer and Tool 2: Static pressure.

The Betz Manometer consist on a water column manometer that will show the height of the water column of the pressure measured by the Prantl tube and a reference pressure that, as with the previous machine, is also ambient pressure.

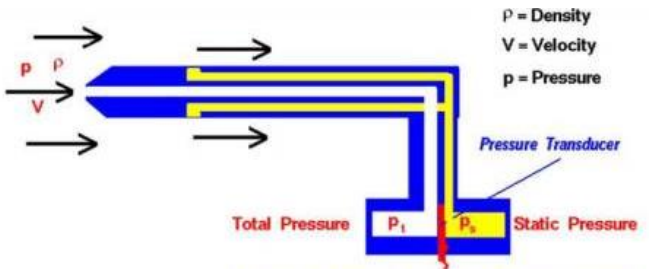


Figure 14. Prandtl tube principle [20].

The Prandtl tube is only connected to the Betz manometer via the secondary ducts (yellow duct in figure 14) so that it directly gives us the static pressure value in terms of millimetres water column height.

Figure 15. Betz Manometer [6].

In the case of dynamic pressure measurements, we will place tool 2 in the centre of the section. This tool is centred on all measurements and as in the previous procedure it has been delayed from mark to mark every 0. 25 meters. For these measures, because we evaluate it at the same flow rates, the safety measures in the previous section must be maintained.

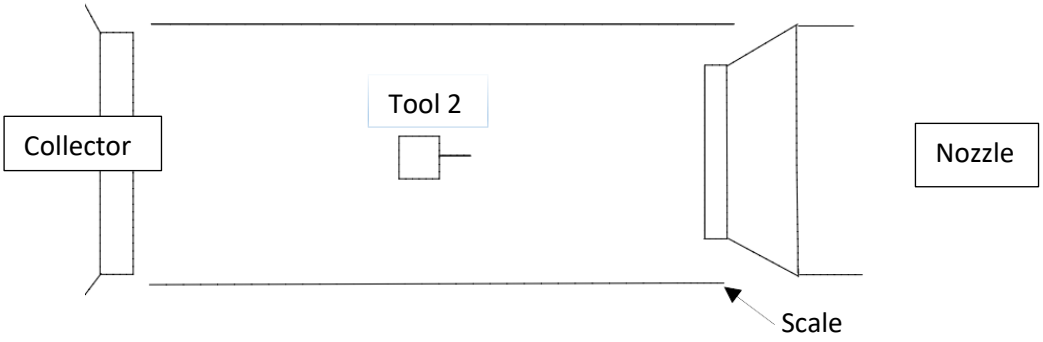


Figure 16. Tool Two Position.

-Problems in measurements:

As this is a totally practical project, it must be considering the different factors that could have caused our measures to be inaccurate. In terms of taking measures, the difficulties have been the following:

-Vibrations: Slight vibrations in the wing of tool 1. These have manifested themselves with speeds of 25m/s and 45m/s from distances of 3. 5 meters in both.

-Side box: In the laboratory, on the left side of the test area, there are a series of boxes with sockets and switches. This box can affect the measurements as the airflow is bouncing off it causes abnormal currents on the left side of the test area.

-Speed of 45m/s: In the case of the test at this speed an unexpected problem has arisen in the middle of the measurements. Due to the strong exposure of Tool 1 to the flow and the protective net (at the entrance of the flow into the tunnel), these two have yielded and suffered damage. Tool 1 has been removed several screws and the network has cracked, compromising tunnel safety. For these reasons, this report at the velocity of 45m/s has only information every metre of distance from the flow outlet.

3.ACHIEVING RESULTS:

The variables that operate in this project are few, but it is necessary to evaluate a lot of data to give a final result. In this section shows how we have obtained the velocities at each point of the test section and then with these data we will make an evaluation of the flow.

The first and most basic aspect that we will use is a formula that allows us to relate the total and static pressures obtained with the speed of the fluid. The main and simple expression that shows us this relationship is Bernoulli's formula. For the application of this formula it is necessary to take into account a series of considerations for each measuring point, these are:

-Stationary flow: A very common assumption, applicable to many flows. Consist on considering that their properties do not change over time.

-Incompressible flow: Consist on assuming that the density does not change in the course of the fluid. This assumption is also quite frequent and more correct in cases where the Mach number is less than 0,3.

-Frictionless flow: In the ISTM wind tunnel, for the application of this principle, is necessary to consider the assumption that the fluid flows through a pipeline. The real case would give rise to a problem of Jet theory of which we do not have the necessary knowledge and this case doesn´t need it either since this approach is very correct. In this project, we will assume that the friction is zero as if the pipe walls did not interfere with the flow (as there are no walls this approach makes the result come closer to reality).

-Flow along a current line: different current lines may have different Bernoulli constants, depending on the flow conditions.

-No motor work between points where the law applies: No pump or turbine in the current line. In the wind tunnel, this is an obvious consideration as the measures are taken in the tunnel test section.

-No heat transfer between points where the law applies: no addiction or heat extraction. [9]

After these conditions have been met, the Bernoulli equation can be applied, an equation related to the energy exchange equation that is expressed in this way:

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} + g * Z_1 = \frac{P_2}{\rho} + \frac{V_2^2}{2} + g * Z_2 + (u_{2-}u_1 - q) + w_t + w_b \qquad (1)\ [9]$$

Taking into account the above considerations, the simplified formula would look like this:

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} = \frac{P_2}{\rho} + \frac{V_2^2}{2} \qquad (2)$$

Continuing this way, we know that the difference of the energies at each point will be the sum of the static pressures plus the dynamic ones, which will add up to the total pressure. So, therefore:

$$P_{tot} = P_{est} + P_{din} \qquad (3)$$

$$P_{din} = \frac{V_1^2 * \rho}{2} \qquad (4)$$

Once this equality is obtained, it is very easy to get the speed according to the measured pressures. It is enough to clear the velocity from the formula (4) and in turn clear the dynamic pressure in equation (3) as a system of equations with two equations and two unknowns. Solving this system leaves us with:

$$\mathrm{v} = \sqrt{\frac{2*\mathrm{P_{din}}}{\rho}} = \sqrt{\frac{2*(Ptot-Pest)}{\rho}} \quad (5)$$

This last formula definitively ends the calculation of the speed from the two pressures obtained in the laboratory. From this formula, we know the air density from the table of air properties ($\rho = 1.28\ kg/m^3, Appendix\ Tables$) and we have as variables at each point the total pressure (measured directly by the machine from Tool 1) and the static pressure.

The static pressure is not obtained directly, but the data we take from the laboratory is the height of the water column of the Betz manometer. In this case, the calculation to remove the static pressure is easy. A simple operation is enough, as shown below:

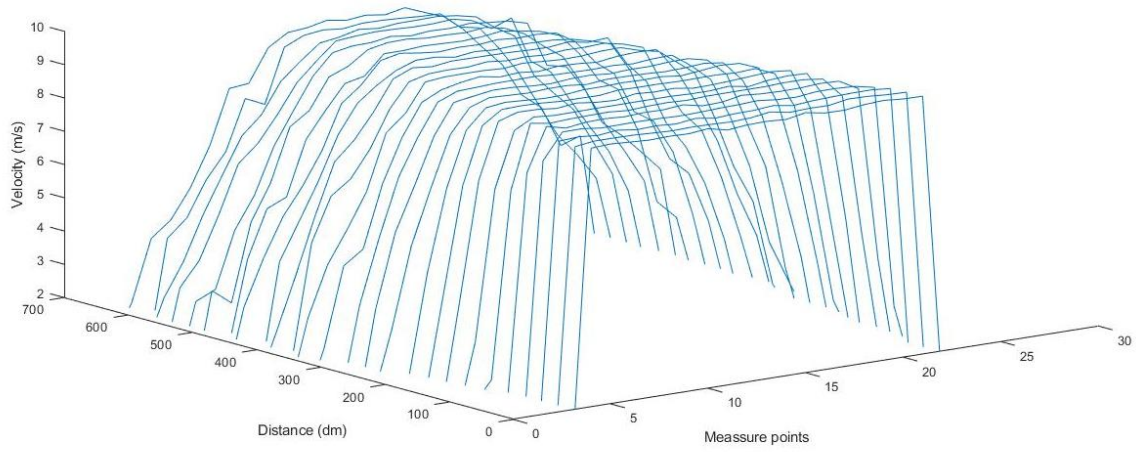
$$P_{est} = \rho * g * h \quad (6)\ [9]$$

Knowing the density of the water ($\rho = 997 \simeq 1000\ kg/m^3$) and the gravity of the earth's atmosphere (*g=9.8m/s*), we can get the static pressure at each point with the height of the water column (h). In this section we have considered that for each distance to the flow outlet the static pressure is the same at each point, therefore, we will use a water column height measurement to calculate the 26 speeds we obtain at each point of the scale.

Once this data is collected, we use Excel to optimize the operations of the multiple points measured, resulting in a complete table with the different points, their total pressure, water column height, static pressure, dynamic pressure and speed. These tables are found in the Appendix Tables.

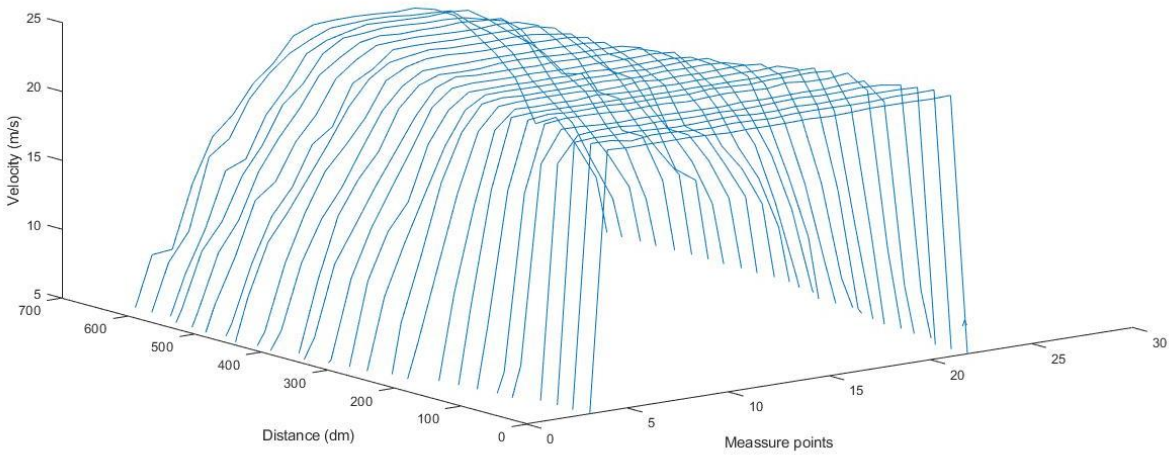
Finally, we will represent the measurements taken in three 3D graphs, one for each speed tested. On each axis we will show: The different measuring points (X axis), the distance at which the measurements are taken (Y axis), and finally the speed at each point (Z axis). These graphs have been made with Matlab and the code is found in Appendix Codes.

-Measures at 10m/s:



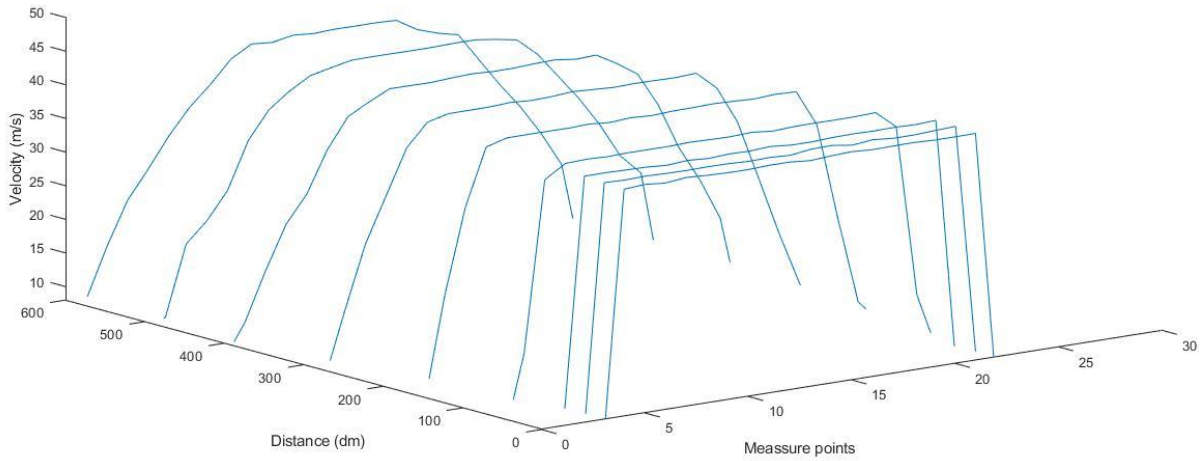
Graph 2. Measures at 10m/s. [10]

- Measures at 25m/s:



Graph 3. Measures at 25m/s. [10]

- Measures at 45m/s:



Graph 4. Measures at 25m/s. [10]

As can be seen in the first two graphs, the speeds are shown every 25dm, while in the case of the 45m/s speed, due to technical problems explained above, we have only been able to collect measurements every metre of distance after the first metre. As a first observation, we can see that the exit speed is very close to that indicated by the tunnel in each test. It also shows us the points (from 0 to 4 and from 21 to 26) that in the initial distances do not pick up

any measurement value as they are not subjected to any flow because they are out of the nozzle's reach, but that later by the expansion of the nozzle will pick up values like the rest. In the nearest distances, there is an almost rectangular profile that curves more and more as we move away. For this reason, these graphs also show how the flow rate varies as we move away from the flow outlet. You can see that the range in which the speeds have a similar value is narrowing. All these phenomena are repeated in the three tests carried out in the same way.

As we move away from the flow outlet it loses the properties of the uniform flow and begins to mix and slow down. This phenomenon begins at the extremes and moves towards the centre, creating on the outside the layer of mixture and a triangle-shaped cores that turns out to be what we are looking for in this project, the triangle called the core part.

POSIBLE SOLUTIONS

1.THEORICAL SOLUTION:

In this section, we will analyse the different solutions that this project can offer. For this purpose, a completely theoretical solution of what is expected to be obtained will be shown first, and then the real solution obtained in practice in the laboratory will be shown.

-Jet theory applied to the Göttinger wind tunnel:

In order to give a theoretical solution to the project in question, many scientists had developed the same problem in similar projects obtaining very different results for the core part length. Some of these theories are shown below and one of them is chosen to justify the choice.

To show an approximation of the range of this layer, in 1976 Rajaratnam established an experimental approximation based on a sinusoidal velocity distribution of the Core part, which determined that the length of the Core part would be about five times the width of the section [11].

$$\mathrm{L}\sim 5 * d_e \quad (8)\ [11]$$

(L:core part length/d_e: $section\ distance$)

Once this theory was developed, many scientists tried to verify it through practical experiments, in which they would find a relationship between the output speed and the length of the boundary layer. According to the experimental data taken at different values of the Reynolds number of Cristophe Bogey and Christophe Bailly from the Ecole Centrale de Lyon, the relationship of Reynolds with the distance of the core part of a subsonic jet (Mach<1) is summarized in the following table [12]:

Jets	Re_D	x_c/r_0
LEShre	4×10^5	10.2
LESre10^4	10^4	10.7
LESre5000	5×10^3	11.3
LESre2500	2.5×10^3	13.0
LESre1700	1.7×10^3	15.9

Figure 17. Core length Reynolds dependence table [12].

For fluid cases above the threshold of $\mathrm{Re} = 10^5$ the scientist, Abramovich suggests that Reynolds has no influence on the core part length. He explains that being a developed turbulent Flow the potential core is independent of the Reynolds. Following the same reasoning Hence proposes a general solution that can be applied to cases where Reynolds has no influence. After developing calculations on the equalities between the centre line velocity and the output speed, he concludes with this formula [13]:

$$\frac{U_m}{U_o} \simeq \frac{6.1\ D}{x}\ [13]$$

($U_m\ centre\ line\ velocity$, $U_o\ initial\ oulet\ velocity$)

Therefore, the length (because in the final of the core part $\frac{U_m}{U_o} = 1$) would be six times the diameter.

Once these ratios have been obtained, it prepares to calculate the Reynolds number for the speeds tested. To make this calculus is important to take into account that the flow outlet section is not a circular tube, but a rectangle with dimensions 180x140. So is necessary a further approximation in which we will take the hydraulic diameter of the section to make a rectangular section problem similar to a circular section problem.

$$d_h = \frac{4*Area}{Perimeter} = \frac{4*(1.8*1,.4)}{(1.8+1.4)*2} = 2.19\ m$$

$$R_e = \frac{\rho * v * d_h}{\mu}$$

Using the properties of the air at room temperature $\mu = 1.849 * 10^{-5}\frac{kg}{m\,s}$ y $\rho = 1.184\frac{kg}{m^3}$ (Table in annexe Tables) the Reynolds numbers obtained are:

$R_{e_{10m/s}}$ =1397620.34

$R_{e_{25m/s}}$ =3494050.85

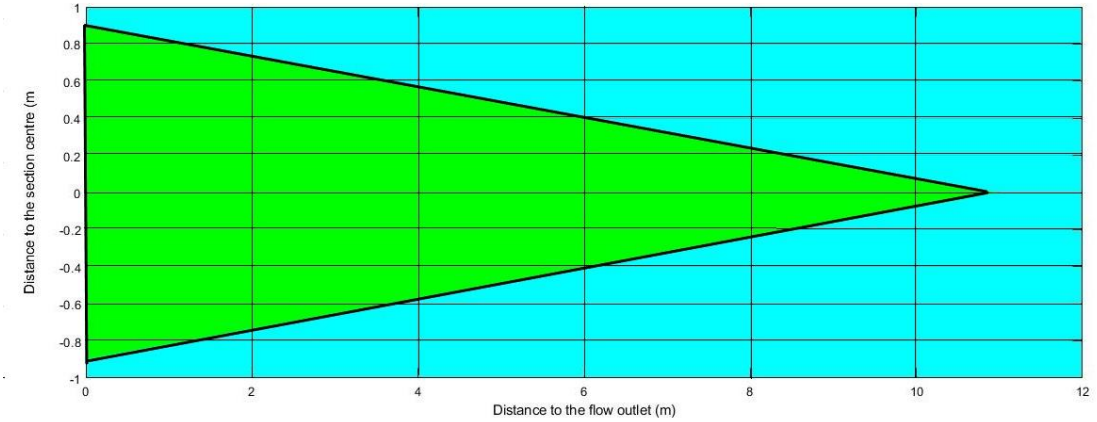
$R_{e_{45m/s}}$ =6289291.53

As we can see, the ISTM wind tunnel is in the case of a developed turbulent flow where the Reynolds has no influence on the length of the core part. Due to the multiple theories at the time of analysing this case, for the development of this project we will choose the most restrictive length, that is, the shortest. Therefore, we will use Rajaratnam's first approach.

So, then the length is:

$$\mathrm{L} \sim 5 * d_e = 5*2.19 = 10.95\mathrm{m}$$

Applying this knowledge to the specific case and knowing the dimensions of the Göttinger wind tunnel a theoretical approximation of what the solution should be can be made. The Core part of the test section. Applying Rajaratnam's approximations to our dimensions fits:



Graph 5. Theorical solution [10].

The Theoretical Core part of our wind tunnel is represented in this graph. On the z-axis, we see the distance from the flow output in meters. On the Y-axis we show the distance to the centre of the output section in parallel with the measuring points of Tool 1. We distinguish the core part from the rest of the fluid with the green colour. This result is obtained in an ideal case of taking measurements and operating the tunnel. In the following sections, we will show that this is not exactly the case.

2.PRACTICAL SOLUTIONS:

Next, we will give the possible real solutions of this thesis, one for each speed tested. These solutions must approach the theoretical solution given above, but as it is a real and experimental solution it brings with it an accumulation of errors and inaccuracies that cause it to deviate from the ideal. In order to provide this solution, we must show the range of measurements that have a velocity similar to the velocity of the flow outflow in the tunnel, which would be part of the Core Part, in order to know which measuring points are within our solution we must establish a tolerance interval that determines which velocities approach the flow outflow velocity. For this, we must analyse the different errors of our machines and measuring tools.

-The uncertainty of experimental data:

When various experimental variables are involved in the calculation of a function, the uncertainty estimates accumulate. If our result P depends on N variables, P= P($X_{1,}X_{2,}X_{3,},\dots,X_n$)), each with its own uncertainty δ_x, the total uncertainty is calculated as the square root of the sum of the squares of all uncertainties:

$$\delta \mathrm{P} = [(\frac{\partial P}{\partial_{X_1}}\delta X_1)^2 + (\frac{\partial P}{\partial_{X_2}}\delta X_2)^2 + (\frac{\partial P}{\partial_{X_3}}\delta X_3)^2 + \dots + (\frac{\partial P}{\partial_{X_n}}\delta X_n)^2]^{(1/2)} \quad (9) \quad [9]$$

If P can be expressed as a product with exponents of the rest of the variables, then each of the derivatives that appear in the equation is proportional to P and the corresponding exponent and is also proportional to the variable in question. If P=cte , ${X_1}^{n_1}{X_2}^{n_2}{X_3}^{n_3}$…, then:

$$\frac{\partial P}{\partial_{X_1}} = \frac{n_1 P}{x_1}, \frac{\partial P}{\partial_{X_2}} = \frac{n_2 P}{x_2}, \frac{\partial P}{\partial_{X_3}} = \frac{n_3 P}{x_3}, \dots, \frac{\partial P}{\partial_{X_n}} = \frac{n_n P}{x_n}$$

So, the equation remains then:

$$\frac{\delta \mathrm{P}}{P} = [(n_1 \frac{\delta x_1}{x_1})^2 + (n_2 \frac{\delta x_2}{x_2})^2 + (n_3 \frac{\delta x_3}{x_3})^2 + \dots + (n_n \frac{\delta x_n}{x_n})^2]$$

-Uncertainty in our measuring machines and considerations:

1. Tunnel speed indicator:

Sentra Acusense

P/N:ASL12R5WDFF2B03A00

Accurancy. +/- 0.07%

2. Total pressure gauge:

Sentra Acusense

P/N:ASL1010MDFF2B03A00

Accurancy. +/- 0.07%

3. Static pressure gauge:

Betz Manometer

Accurancy. +/- 1%

4. Consideration of measurement conditions at ambient temperature:

In this project, we have operated with the properties of air at room temperature assuming that every day we have taken measurements in the laboratory we were at a temperature of 20ºC and an atmosphere. Temperature is an element that varies easily and causes the properties of air to vary. Due to this, we are mainly faced with an added uncertainty in our measurements. In this case, it affects the air density. It was originally used ($\rho(20^oC) = 1.28\ kg/m^3$). But if we look at the average temperatures of the city of Karlsruhe in May we find that the average temperature is $14{,}4^oC$ [14]. With this information and using the tables of air properties at 1 atm pressure, we can interpolate and extract the density at this temperature.

TABLE C.1 Physical Properties of Air at Standard Atmospheric Pressure (SI Units)*

Temperature (°C)	Density, ρ (kg/m³)	Dynamic viscosity, μ (N·s/m²)	Kinematic viscosity, ν (m²/s)	Specific heat ratio, γ
−40	1.514	1.57 E − 5	1.04 E − 5	1.401
−20	1.395	1.63 E − 5	1.17 E − 5	1.401
0	1.292	1.71 E − 5	1.32 E − 5	1.401
5	1.269	1.73 E − 5	1.36 E − 5	1.401
10	1.247	1.76 E − 5	1.41 E − 5	1.401
15	1.225	1.80 E − 5	1.47 E − 5	1.401
20	1.204	1.82 E − 5	1.51 E − 5	1.401
25	1.184	1.85 E − 5	1.56 E − 5	1.401
30	1.165	1.86 E − 5	1.60 E − 5	1.400
40	1.127	1.87 E − 5	1.66 E − 5	1.400
50	1.109	1.95 E − 5	1.76 E − 5	1.400
60	1.060	1.97 E − 5	1.86 E − 5	1.399
70	1.029	2.03 E − 5	1.97 E − 5	1.399
80	0.9996	2.07 E − 5	2.07 E − 5	1.399
90	0.9721	2.14 E − 5	2.20 E − 5	1.398
100	0.9461	2.17 E − 5	2.29 E − 5	1.397
200	0.7461	2.53 E − 5	3.39 E − 5	1.390
300	0.6159	2.98 E − 5	4.84 E − 5	1.379
400	0.5243	3.32 E − 5	6.34 E − 5	1.368
500	0.4565	3.64 E − 5	7.97 E − 5	1.357
1000	0.2772	5.04 E − 5	1.82 E − 4	1.321

* Based on data from R. D. Blevins, *Applied Fluid Dynamics Handbook*, Van Nostrand Reinhold Co., Inc., New York, 1984.

Figure 18. Air properties Table [18]

$$\rho(20^oC) = 1.28\ kg/m^3$$

$$\rho(20^oC) = 1.28\ kg/m^3$$

Poliomic interpolation of Lagrange:

$$\frac{\rho(14.4^oC) - \rho(10^oC)}{\rho(15^oC) - \rho(10^oC)} = \frac{14.4 - 10}{15 - 10}$$

Then we coclude that:

$$\rho(14{,}4^oC) = 1.2292\ kg/m^3$$

Therefore, having this new density data we can remove the density error:

$$\delta\rho = \frac{\rho(14.4^oC) - \rho(20^oC)}{\rho(20^oC)} = 3.96\%$$

Once we have obtained the uncertainties of all the variables used to calculate our velocities we will apply the uncertainty theory of the experimental data. To do this, we will follow the same order of calculation as when we have taken the measurements:

- Static pressure uncertainty:

$$P_{est} = \rho * g * h$$

We apply (1) with the density and height variables (uncertainty of the measuring machine):

$$\delta P_{est} = [(1 * 3{,}96)^2 + (1)^2]^{(\frac{1}{2})} = 4{,}084311\%$$

- The uncertainty of dynamic pressure:

$$P_{din} = P_{tot} - P_{est}$$

As it is a subtraction, the uncertainties of the static and dynamic pressure variables (uncertainty of both measuring machines) are added:

$$\delta P_{din} = 0.07 + 4.084311 = 4.154311\%$$

- The uncertainty of speed:

$$v = \sqrt{\frac{2 * P_{din}}{\rho}}$$

We apply (1) with the variables of dynamic pressure and density:

$$\delta v = [(\frac{1}{2} * 4.154311)^2 + (\frac{1}{2} * 3.96)^2]^{(\frac{1}{2})} = 2.869\%$$

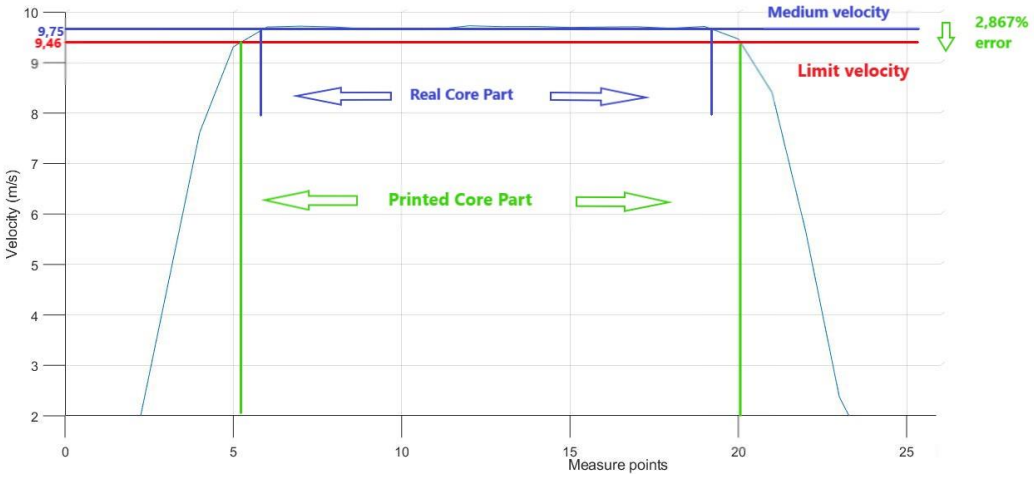
Obtaining the value of the uncertainty of the velocity we arrive at the objective of all the calculations of the uncertainties in this project. This value will serve as a reference for selecting the range of speeds that will become part of our possible practical solutions.

-Practical solutions:

These solutions are three, one for each speed tested. For them, we have used the speed error to get the lowest speed limit that has to be in our Core Part. The speed error has been applied to the average speeds of all three-speed measurements at the zero point. The reason why we applied it at this speed and not at the tunnel exit speed is that of the difference between these two with respect to the small error of almost three per cent. The tunnel exit speed does not have the added uncertainties of the two measuring tools, the approximation of using a single static pressure measurement for all points at the same distance and the problems that have arisen when enhancing the measurements such as vibrations, detachments, etc. With this, it remains for us that the limit speeds are:

Tunnel Velocity	*Medium velocity*	*Error (+/-)*	*Limit velocity*
10 m/s	9.7528 m/s	0.2869 m/s	9.4659 m/s
25 m/s	23.8990 m/s	0.7172 m/s	23.1818 m/s
45 m/s	41.7637 m/s	1.2910 m/s	40.4726 m/s

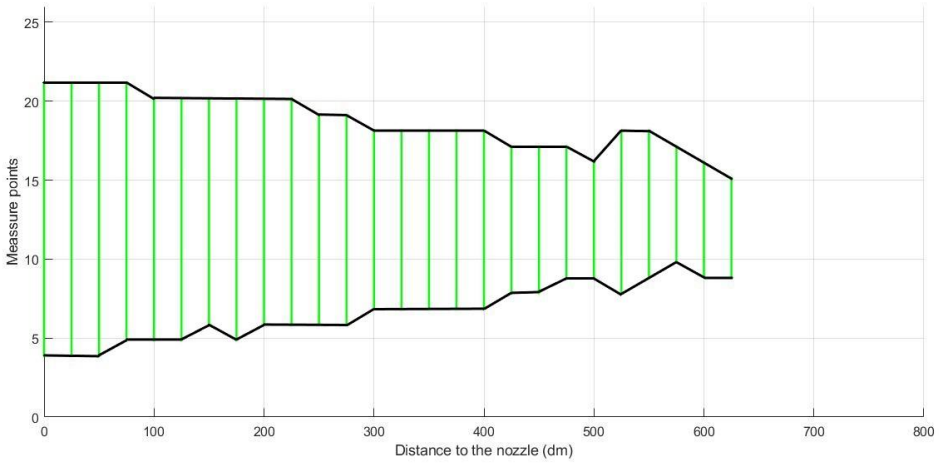
In this way, we can apply the error obtained to all the speed profiles obtained in the measurements. The following figure shows an example of iteration in which the error is applied to one of the speed profiles in order to get the extension at that point of the core part.



Graph 6. Error application [10].

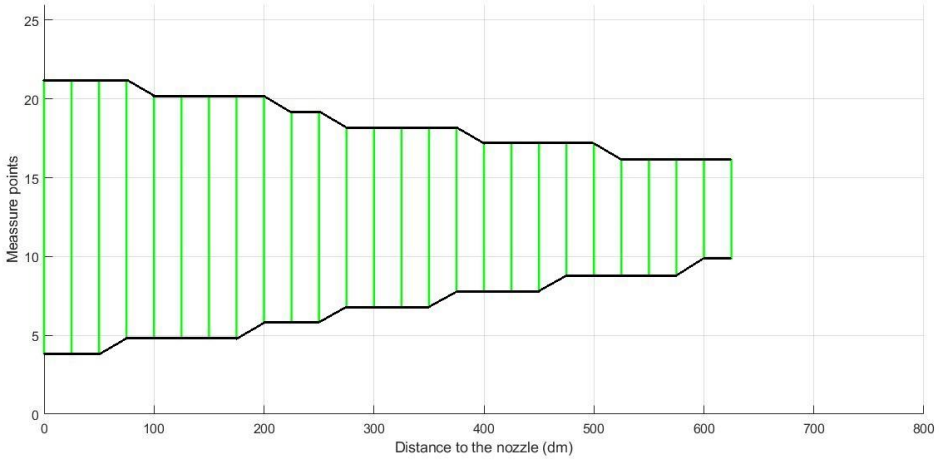
To represent the points that are within these limits we will use an Excel function that will mark in a box a 1 if the number is inside the core part and a 0 if it is outside. In this way, in the same axes this scale of ones is represented only in the x-axes and y-axes, so the following solutions are obtained from the Core part:

In 10 m/s:



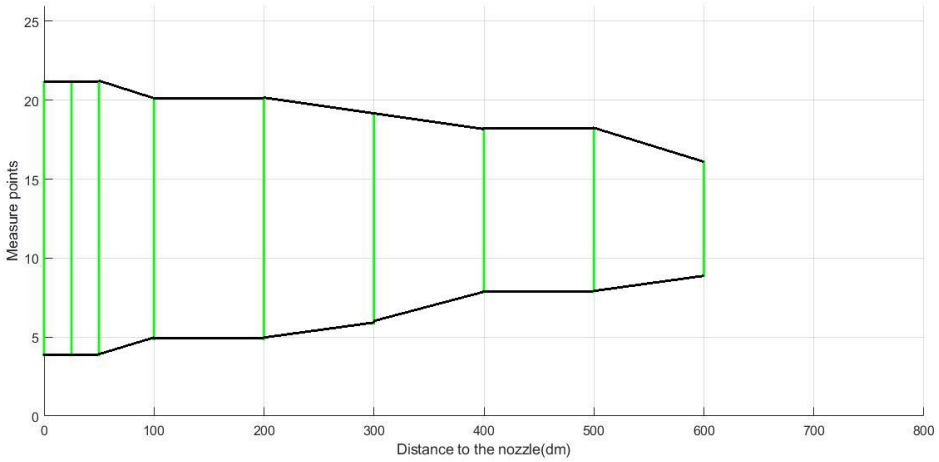
Graph 7. Core part at 10 m/s [10].

In 25 m/s:



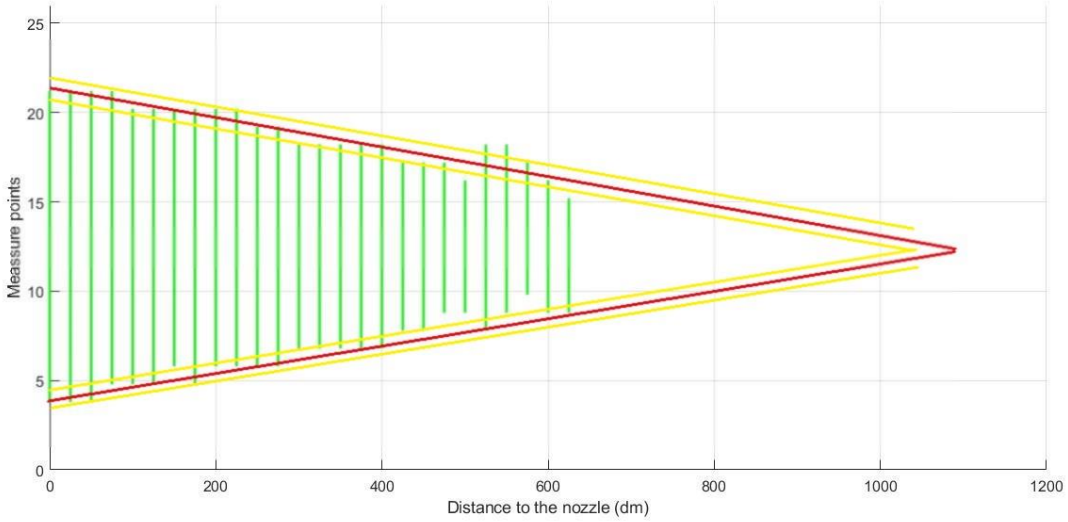
Graph 8. Core part at 25 m/s [10].

In 45 m/s:

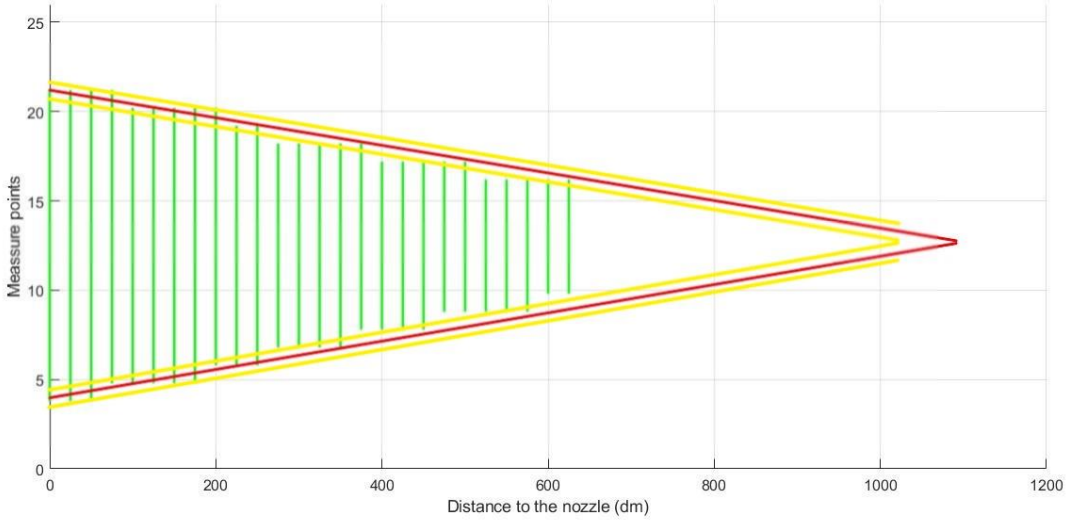


Graph 9. Core part at 45 m/s [10].

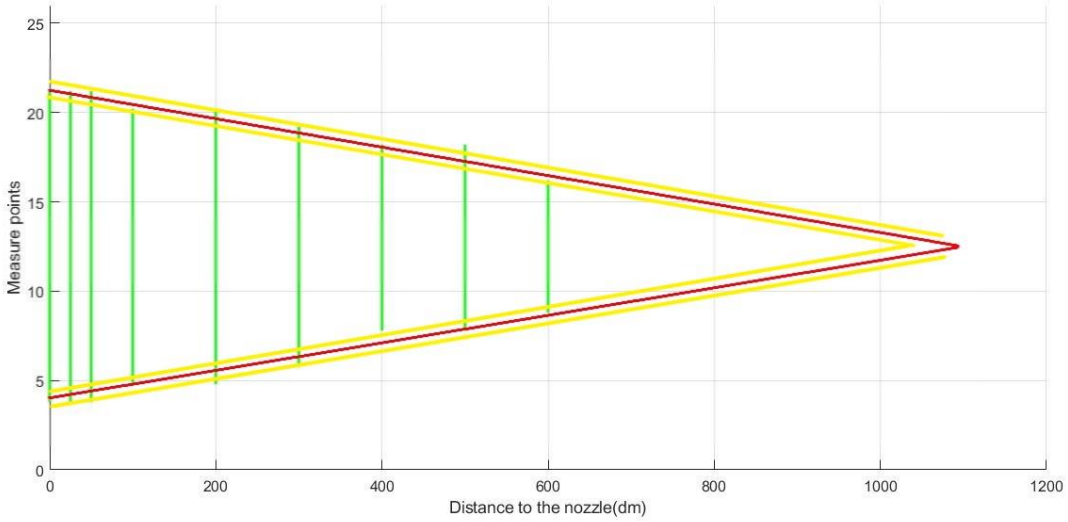
With the obtaining of these results, it must be verified that they are adapted to the theoretical estimation given previously to later give a general final result for the wind tunnel. The practical results are illustrated below in green and the theoretical estimate for the different speeds in red:



Graph 10. Core part comparison at 10 m/s [10].



Graph 11. Core part comparison at 25 m/s [10].



Graph 12. Core part comparison at 45 m/s [10].

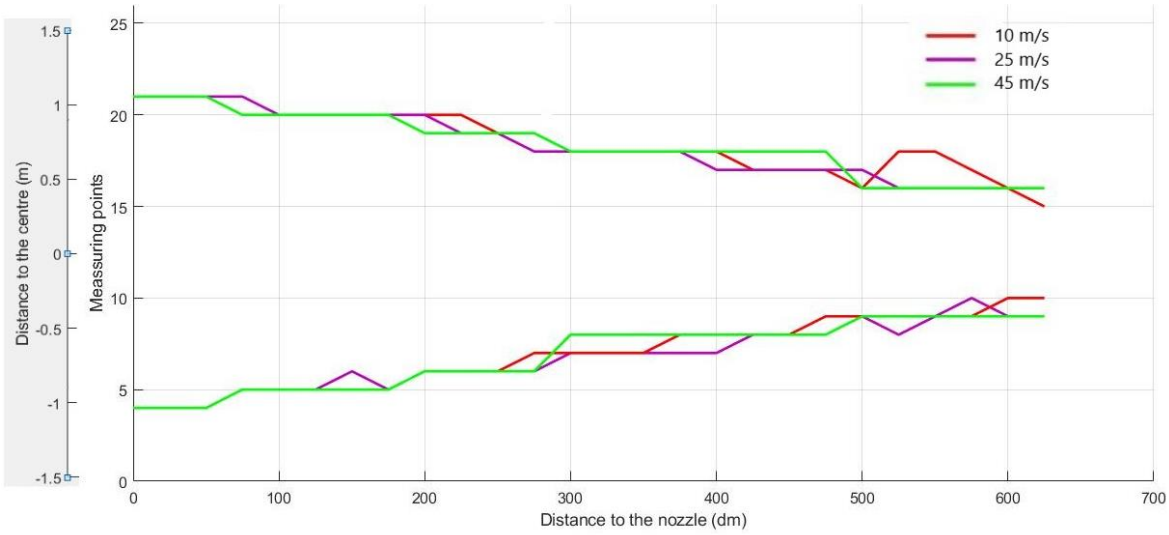
In these three graphs the practical result obtained is shown in green, the theoretical result in red and the allowed accuracy in yellow. The error we have applied to the theoretical result is the same as the one you have given us when calculating the errors in the measuring machines. With this process, we check whether or not our data is within the error that results from the use of our devices.

As shown in the graphs, there are points that are not within the error range. Many of them coincide at a distance of about 4 meters. This may be a consequence of one of the problems mentioned above with taking action. At this distance is the power box located on the right side that affects the development of our flow by bouncing it off it and causing errors in the measurements. On the other hand, it may also be due to the vibrations that the Tool 1 has undergone in the test of the speeds 25 m/s and 45 m/s from a distance of three meters.

Drawing a general conclusion from this solution, we can see in the three graphs that the theoretical and practical results are very similar to each other, therefore, it can be said that the expected measures and results have been collected and obtained. It can also be verified that the statement that with Reynolds values higher than $\mathrm{Re} = 10^5$ it does not have a notable influence on the length of the core part is correct. A similar triangle is found in all three trials.

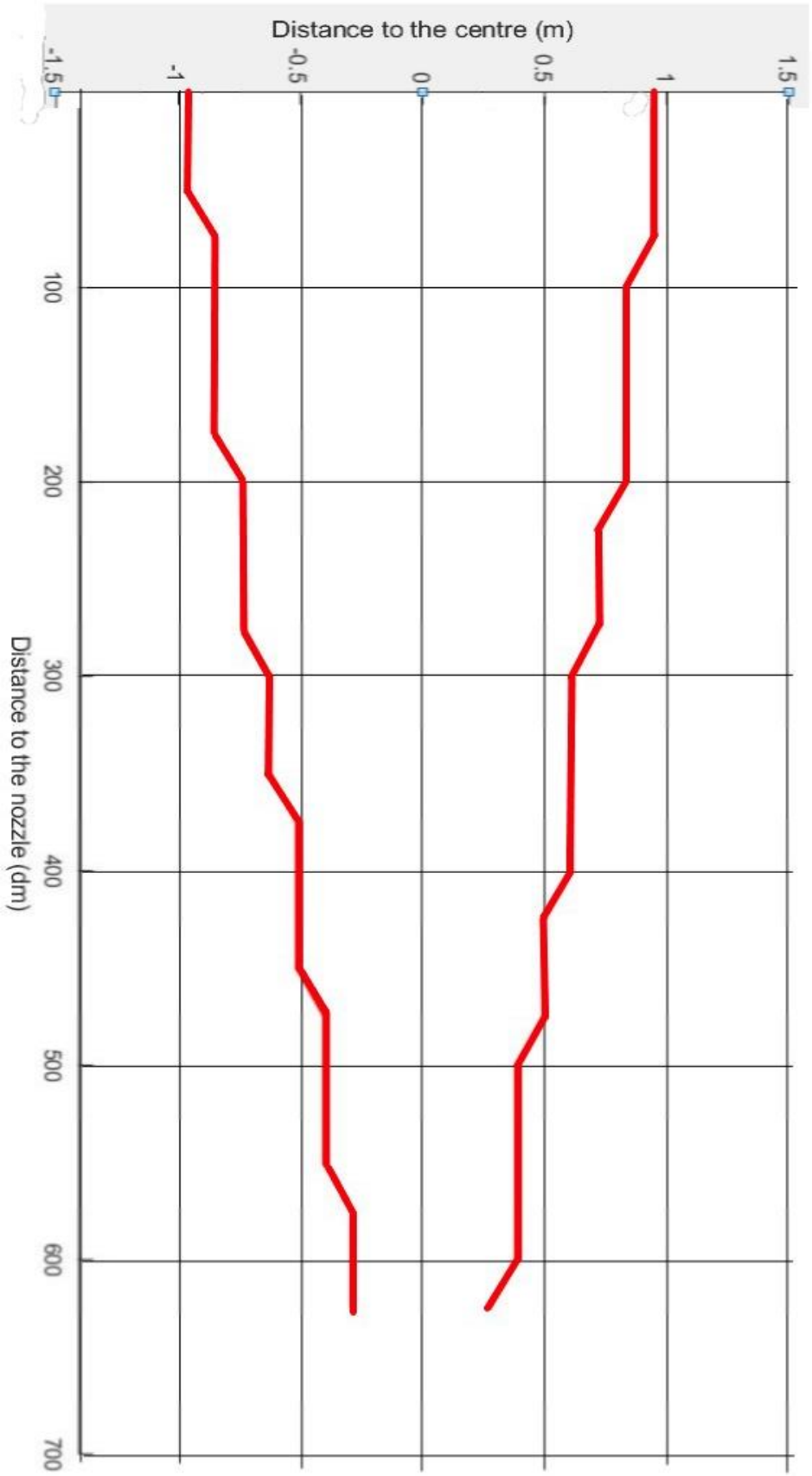
FINAL SOLUTION

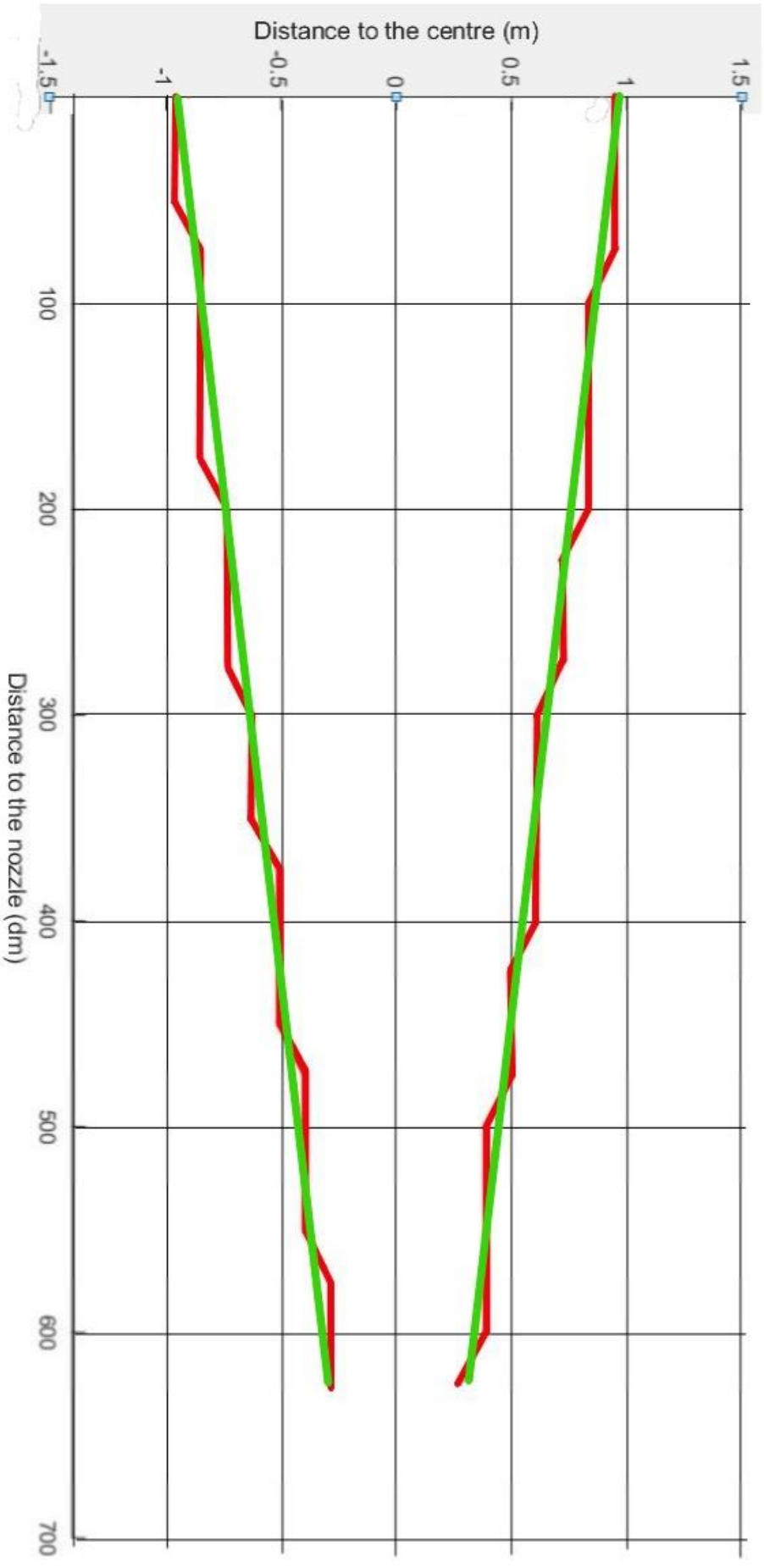
The development of this project aims at a final solution which is the extension of the general core part of the tunnel. If this were to vary with speed, there would be multiple possible solutions depending on different Reynolds numbers. As it has been demonstrated previously that in our case Reynolds does not affect the solution, we will give a single result consisting of the average of the three tests performed. First, an illustration is shown with the three results together in the same graph.



Graph 13. Core parts at the tested velocities [10].

As you can see, the results of the three speeds are shown in three different colours. For the elaboration of a definitive solution of the tunnel, the average of the solutions at the three different speeds has been carried out, resulting in the following graph:


Distance to the centre (m)
-1.5
-1
-0.5
0
0.5
1
1.5
100
200
300
400
500
600
700
Distance to the nozzle (dm)


Distance to the centre (m)
-1.5
-1
-0.5
0
0.5
1
1.5
Distance to the nozzle (dm)
100
200
300
400
500
600
700

FUTURE PROJECTS

To improve the flow of the ISTM wind tunnel, the department has chosen to make a series of changes. First, the test area has been cleared of flow-distorting elements, such as the left-hand outlet box. Apart from these small changes, it has been decided to make a change in the diffuser geometry, as shown in the figure.

Figure 19. New wind tunnel diffuser [6].

This new geometry makes it possible to make more use of the tunnel's energy. Its function is to collect most of the air coming out of the nozzle and use its energy in the form of speed to reduce the work of the tunnel. Compared to the previous diffuser, this one has a larger diameter and a geometry that prevents a large part of the air that deviates and does not enter directly through the circular geometry of the same.

As mentioned at the beginning of this work, the ISTM Göttinger wind tunnel is a tunnel that is subject to constant improvement. For this reason, this variant in it will not be the last, nor will the flow evaluation have showed here.

BIBLIOGRAPHY

BIBLIOGRAPHY:

[1] S. B. Jochen Kriegseis, *Messung Statik Windkannal,* Karlsruhe, 2017.

[2] "Ecured," [Online]. Available: https://www.ecured.cu/T%C3%BAnel_aerodin%C3%A1mico. [Accessed 30 July 2018].

[3] "blogodisea," [Online]. Available: http://www.blogodisea.com/que-usos-tienen-tuneles-de-viento.html. [Accessed 2018 July 30].

[4] E. G. Ramirez, 2005.

[5] F. M. Estrada, "Clasificación de los túneles de viento," University of Guadalajara, Guadalajara, 2018.

[6] J. L. Areses, *Fotografía del Laboratorio(ISTM).,* Karlsruhe, 2018.

[7] C. L. -. H. &. S. Laboratory, "http://www.kbwiki.ercoftac.org," Health & Safety Laboratory, 19 October 2011. [Online]. Available: http://www.kbwiki.ercoftac.org/w/index.php/Abstr:Underexpanded_jet. [Accessed 18 July 2018].

[8] J. U. Lobo, "web.stanford.edu," 1 September 2005. [Online]. Available: https://web.stanford.edu/~jurzay/UrzayMScfinal.pdf. [Accessed 19 July 2018].

[9] F. White, Mecánica de fluídos, McGraw-Hill, 2004.

[10] J. L. Areses, *Matlab Graphs,* Karlsruhe, 2018.

[11] D. Heinze, Physically-Based Models for Two-Phase Flow Phenomena in Steam Injectors : A One-dimensional simulation aproach, Karlsruhe: KIT cientific publishing.

[12] C. B. Christophe Bogey, "Influence of the Reynolds number on the flow development and energy disipation," Ecole Centrale Lyon, Lyon, 2006.

[13] NASA, "SURVEY OF LITERATURE ON FLOW CHARACHTERISTICS OF A SINGLE TURBULENT JET," 1970. [Online]. Available: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19700009658.pdf. [Accessed 1 August 2018].

[14] "Climate data ORG," 2018. [Online]. Available: https://es.climate-data.org/location/2143/. [Accessed 22 July 2018].

[15] J. K. Sebastian Banz, "Messung Statik Windkannal," Karlsruhe, 2017.

[16] “www.ebay-kleinanzeigen.de/s-craft-heissklebepistole/k0,” [Online]. Available: https://www.heissklebepistole.de/dokumente/WebprospektPDF.pdf. [Accessed 16 July 2018].

[17] “www.jbctools.com,” [Online]. Available: https://www.jbctools.com/pdf/EXPLODED_PENCIL_LINE.pdf. [Accessed 16 July 2018].

[18] “www.chegg.com,” [Online]. Available: https://www.chegg.com/homework-help/questions-and-answers/table-c1-physical-properties-air-standard-atmospheric-pressure-si-units-dynamic-viscosity--q23762599. [Accessed 22 July 2018].

[19] “ww2enimagenes,” [Online]. Available: http://www.ww2enimagenes.com/2015/06/tunel-de-viento-aleman-en-adlershof.html. [Accessed 2018 July 30].

[20] T. Benson, “NASA,” Glenn Research Cetre, 10 June 2014. [Online]. Available: https://www.grc.nasa.gov/WWW/K-12/BGP/pitot.html. [Accessed 2 August 2018].

APPENDIX

APENDIX

APENDIX 1. Tables:

1.1.Table of background measures:

	6mmWs		38mmWs		113mmWs	
	h_mess [mm]	p_stat	h_mess [mm]	p_stat	h_mess [mm]	p_stat
0	0,12	1,1772	0,3	2,943	1,3	12,753
25	0,08	0,7848	0,1	0,981	0,5	4,905
50	0,05	0,4905	0,09	0,8829	0,32	3,1392
75	0,04	0,3924	0,11	1,0791	0	0
100	0,05	0,4905	0,12	1,1772	0,4	3,924
125	0,05	0,4905	0,15	1,4715	0,3	2,943
150	0,05	0,4905	0,23	2,2563	0,3	2,943
175	0,06	0,5886	0,35	3,4335	0,35	3,4335
200	0,08	0,7848	0,41	4,0221	0,3	2,943
225	0,08	0,7848	0,49	4,8069	0,35	3,4335
250	0,09	0,8829	0,61	5,9841	0,38	3,7278
275	0,1	0,981	0,78	7,6518	0,4	3,924
300	0,1	0,981	0,8	7,848	0,1	0,981
432,5	0,09	0,8829	0,75	7,3575	-1,2	-11,772
450	0,08	0,7848	0,65	6,3765	-1,35	-13,2435
475	0,05	0,4905	0,5	4,905	-1,4	-13,734
500	0,06	0,5886	0,4	3,924	-1,45	-14,2245
525	0,05	0,4905	0,35	3,4335	-1,35	-13,2435
550	0,08	0,7848	0,31	3,0411	-1,15	-11,2815
575	0,09	0,8829	0,38	3,7278	0,1	0,981
600	0,11	1,0791	0,58	5,6898	1	9,81

1.2. Tables of measures at 10 m/s:

The information of this tables can be found in a Excel document named “Results and operatios”.

DISTANCE 0 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-24716,00	0,13	1,27	-1,03	1,26666393
100000,00	-114787,00	0,13	1,27	-0,13	0,44393482
200000,00	-120976,00	0,13	1,27	-0,06	0,31682014
300000,00	-134564,00	0,13	1,27	0,07	0,33457062
400000,00	6245625,00	0,13	1,27	61,18	9,77738542
500000,00	6287279,00	0,13	1,27	61,60	9,81061208
600000,00	6242238,00	0,13	1,27	61,15	9,7746787
700000,00	6199895,00	0,13	1,27	60,72	9,74077689
800000,00	6223874,00	0,13	1,27	60,96	9,75999007
900000,00	6201640,00	0,13	1,27	60,74	9,74217635
1000000,00	6274519,00	0,13	1,27	61,47	9,80044562
1100000,00	6108768,00	0,13	1,27	59,81	9,66741305
1200000,00	6182602,00	0,13	1,27	60,55	9,72689731
1300000,00	6199195,00	0,13	1,27	60,72	9,74021544
1400000,00	6152039,00	0,13	1,27	60,25	9,70231851
1500000,00	6290667,00	0,13	1,27	61,63	9,81330968
1600000,00	6161361,00	0,13	1,27	60,34	9,70982186
1700000,00	6153058,00	0,13	1,27	60,26	9,70313899
1800000,00	6239232,00	0,13	1,27	61,12	9,77227584
1900000,00	6282542,00	0,13	1,27	61,55	9,80683913
2000000,00	6218615,00	0,13	1,27	60,91	9,75577954
2100000,00	6206466,00	0,13	1,27	60,79	9,74604567
2200000,00	-173608,00	0,13	1,27	0,46	0,84970583
2300000,00	-58462,00	0,13	1,27	-0,69	1,03786138
2400000,00	-75705,00	0,13	1,27	-0,52	0,89874044
2500000,00	-95609,00	0,13	1,27	0,96	1,22224818
2600000,00	-75068,00	0,13	1,27	0,75	1,08302239

DISTANCE 0,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-97939,00	0,08	0,78	0,20	0,55253676
100000,00	-228875,00	0,08	0,78	1,50	1,53335315
200000,00	-202515,00	0,08	0,78	1,24	1,3925864
300000,00	-129521,00	0,08	0,78	0,51	0,89373689
400000,00	6092353,00	0,08	0,78	60,14	9,69371011
500000,00	6184996,00	0,08	0,78	61,07	9,76808899
600000,00	6183392,00	0,08	0,78	61,05	9,76680603
700000,00	6174401,00	0,08	0,78	60,96	9,75961145
800000,00	6135077,00	0,08	0,78	60,57	9,72808193
900000,00	6101916,00	0,08	0,78	60,24	9,7014142
1000000,00	6125220,00	0,08	0,78	60,47	9,72016268
1100000,00	6110945,00	0,08	0,78	60,33	9,70868249
1200000,00	6082598,00	0,08	0,78	60,04	9,68584502
1300000,00	6117975,00	0,08	0,78	60,40	9,71433782
1400000,00	6221175,00	0,08	0,78	61,43	9,79698216
1500000,00	6090506,00	0,08	0,78	60,12	9,69222143
1600000,00	6123641,00	0,08	0,78	60,45	9,71889349
1700000,00	6113619,00	0,08	0,78	60,35	9,71083399
1800000,00	6237679,00	0,08	0,78	61,59	9,81013427
1900000,00	6221901,00	0,08	0,78	61,44	9,79756108
2000000,00	6167270,00	0,08	0,78	60,89	9,75390146
2100000,00	6145252,00	0,08	0,78	60,67	9,73624992
2200000,00	-112355,00	0,08	0,78	0,34	0,72838649
2300000,00	-82938,00	0,08	0,78	0,05	0,26628228
2400000,00	-124643,00	0,08	0,78	0,46	0,85002757
2500000,00	-104994,00	0,08	0,78	1,05	1,28083225
2600000,00	-74240,00	0,08	0,78	0,74	1,07703296

DISTANCE 0,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-99518,00	0,09	0,88	0,11	0,42052794
100000,00	-163993,00	0,09	0,88	0,76	1,08823969
200000,00	-196631,00	0,09	0,88	1,08	1,30162759
300000,00	-173620,00	0,09	0,88	0,85	1,15528676
400000,00	6145214,00	0,09	0,88	60,57	9,72835257
500000,00	6188549,00	0,09	0,88	61,00	9,76309137
600000,00	6125870,00	0,09	0,88	60,38	9,71280566
700000,00	6204760,00	0,09	0,88	61,17	9,77605493
800000,00	6106399,00	0,09	0,88	60,18	9,6971315
900000,00	6137497,00	0,09	0,88	60,49	9,72215334
1000000,00	6086342,00	0,09	0,88	59,98	9,68095908
1100000,00	6179164,00	0,09	0,88	60,91	9,75557853
1200000,00	6071175,00	0,09	0,88	59,83	9,66871162
1300000,00	6118662,00	0,09	0,88	60,30	9,70700617
1400000,00	6130187,00	0,09	0,88	60,42	9,71627742
1500000,00	6192802,00	0,09	0,88	61,05	9,76649406
1600000,00	6076142,00	0,09	0,88	59,88	9,67272422
1700000,00	6136580,00	0,09	0,88	60,48	9,72141643
1800000,00	6167703,00	0,09	0,88	60,80	9,74639597
1900000,00	6189046,00	0,09	0,88	61,01	9,76348907
2000000,00	6193757,00	0,09	0,88	61,06	9,76725796
2100000,00	6130136,00	0,09	0,88	60,42	9,71623641
2200000,00	5872,00	0,09	0,88	-0,82	1,13418473
2300000,00	-93788,00	0,09	0,88	0,06	0,29548689
2400000,00	-61901,00	0,09	0,88	-0,26	0,64103188
2500000,00	-82734,00	0,09	0,88	0,83	1,1369779
2600000,00	-57877,00	0,09	0,88	0,58	0,95096168

DISTANCE 0,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-73069,00	0,09	0,88	-0,15	0,48623233
100000,00	-173939,00	0,09	0,88	0,86	1,15744195
200000,00	-88452,00	0,09	0,88	0,00	0,0627495
300000,00	30297,00	0,09	0,88	-0,58	0,95117526
400000,00	5277334,00	0,09	0,88	51,89	9,00445549
500000,00	6207498,00	0,09	0,88	61,19	9,77824275
600000,00	6213178,00	0,09	0,88	61,25	9,78277983
700000,00	6123641,00	0,09	0,88	60,35	9,7110126
800000,00	6136860,00	0,09	0,88	60,49	9,72164145
900000,00	6142972,00	0,09	0,88	60,55	9,72655193
1000000,00	6129321,00	0,09	0,88	60,41	9,71558108
1100000,00	6104463,00	0,09	0,88	60,16	9,69557164
1200000,00	6122903,00	0,09	0,88	60,35	9,71041886
1300000,00	6156394,00	0,09	0,88	60,68	9,7373267
1400000,00	6175394,00	0,09	0,88	60,87	9,75255896
1500000,00	6211726,00	0,09	0,88	61,24	9,7816202
1600000,00	6131715,00	0,09	0,88	60,44	9,71750595
1700000,00	6111671,00	0,09	0,88	60,23	9,70137796
1800000,00	6197463,00	0,09	0,88	61,09	9,77022182
1900000,00	6201105,00	0,09	0,88	61,13	9,77313361
2000000,00	6162074,00	0,09	0,88	60,74	9,74188284
2100000,00	6010330,00	0,09	0,88	59,22	9,61942209
2200000,00	646022,00	0,09	0,88	5,58	2,95228196
2300000,00	-51917,00	0,09	0,88	-0,36	0,75294215
2400000,00	-90795,00	0,09	0,88	0,03	0,20136255
2500000,00	-49204,00	0,09	0,88	0,49	0,87681954
2600000,00	-63378,00	0,09	0,88	0,63	0,99512876

DISTANCE 1 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-53076,00	0,07	0,69	-0,16	0,49250635
100000,00	-155079,00	0,07	0,69	0,86	1,16242607
200000,00	-131698,00	0,07	0,69	0,63	0,99292812
300000,00	267693,00	0,07	0,69	1,99	1,76375399
400000,00	4712585,00	0,07	0,69	46,44	8,51834876
500000,00	6230586,00	0,07	0,69	61,62	9,81228981
600000,00	6055563,00	0,07	0,69	59,87	9,67193346
700000,00	6153313,00	0,07	0,69	60,85	9,7505713
800000,00	6172414,00	0,07	0,69	61,04	9,7658637
900000,00	6127118,00	0,07	0,69	60,59	9,72956031
1000000,00	6167181,00	0,07	0,69	60,99	9,7616765
1100000,00	6156242,00	0,07	0,69	60,88	9,75291783
1200000,00	6223429,00	0,07	0,69	61,55	9,80658978
1300000,00	6070348,00	0,07	0,69	60,02	9,68386867
1400000,00	6089182,00	0,07	0,69	60,21	9,69905118
1500000,00	6229427,00	0,07	0,69	61,61	9,81136697
1600000,00	6167550,00	0,07	0,69	60,99	9,76197182
1700000,00	6144666,00	0,07	0,69	60,76	9,74364055
1800000,00	6151619,00	0,07	0,69	60,83	9,74921391
1900000,00	6201882,00	0,07	0,69	61,33	9,78940914
2000000,00	6174656,00	0,07	0,69	61,06	9,76765709
2100000,00	5782612,00	0,07	0,69	57,14	9,44888552
2200000,00	1218347,00	0,07	0,69	11,50	4,23848993
2300000,00	-88898,00	0,07	0,69	0,20	0,56316627
2400000,00	-63454,00	0,07	0,69	-0,05	0,28355996
2500000,00	-74546,00	0,07	0,69	0,75	1,07925032
2600000,00	-65199,00	0,07	0,69	0,65	1,00932372

DISTANCE 1,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-78265,00	0,08	0,78	0,00	0,04592793
100000,00	-178650,00	0,08	0,78	1,00	1,25156152
200000,00	-232937,00	0,08	0,78	1,55	1,5539114
300000,00	402054,00	0,08	0,78	3,24	2,24879829
400000,00	4027037,00	0,08	0,78	39,49	7,85477263
500000,00	6197540,00	0,08	0,78	61,19	9,77811651
600000,00	6082535,00	0,08	0,78	60,04	9,6857942
700000,00	6122559,00	0,08	0,78	60,44	9,71802369
800000,00	6139025,00	0,08	0,78	60,61	9,73125201
900000,00	6150116,00	0,08	0,78	60,72	9,74015208
1000000,00	6091028,00	0,08	0,78	60,13	9,69264218
1100000,00	6133893,00	0,08	0,78	60,55	9,72713103
1200000,00	6153109,00	0,08	0,78	60,75	9,74255244
1300000,00	6118382,00	0,08	0,78	60,40	9,71466514
1400000,00	6155987,00	0,08	0,78	60,78	9,74486002
1500000,00	6161768,00	0,08	0,78	60,83	9,74949358
1600000,00	6164022,00	0,08	0,78	60,86	9,75129959
1700000,00	6163271,00	0,08	0,78	60,85	9,75069789
1800000,00	6197705,00	0,08	0,78	61,19	9,77824834
1900000,00	6193987,00	0,08	0,78	61,16	9,77527733
2000000,00	6102247,00	0,08	0,78	60,24	9,70168075
2100000,00	5373976,00	0,08	0,78	52,96	9,09633855
2200000,00	1575307,00	0,08	0,78	14,97	4,8362353
2300000,00	-9447,00	0,08	0,78	-0,69	1,03797429
2400000,00	-107350,00	0,08	0,78	0,29	0,67256505
2500000,00	-99837,00	0,08	0,78	1,00	1,24898083
2600000,00	-64881,00	0,08	0,78	0,65	1,00685929

DISTANCE 1,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-47867,00	0,09	0,88	-0,40	0,79385334
100000,00	-146509,00	0,09	0,88	0,58	0,95450413
200000,00	-136856,00	0,09	0,88	0,49	0,87192316
300000,00	776537,00	0,09	0,88	6,88	3,27952216
400000,00	3943512,00	0,09	0,88	38,55	7,76139485
500000,00	5779862,00	0,09	0,88	56,92	9,43038805
600000,00	6163831,00	0,09	0,88	60,76	9,74329176
700000,00	6099026,00	0,09	0,88	60,11	9,69118962
800000,00	6103470,00	0,09	0,88	60,15	9,69477146
900000,00	6114689,00	0,09	0,88	60,26	9,70380805
1000000,00	6114040,00	0,09	0,88	60,26	9,70328553
1100000,00	6118089,00	0,09	0,88	60,30	9,70654499
1200000,00	6117427,00	0,09	0,88	60,29	9,70601215
1300000,00	6116994,00	0,09	0,88	60,29	9,70566362
1400000,00	6090124,00	0,09	0,88	60,02	9,68401066
1500000,00	6086508,00	0,09	0,88	59,98	9,68109304
1600000,00	6144526,00	0,09	0,88	60,56	9,72780005
1700000,00	6016863,00	0,09	0,88	59,29	9,62472646
1800000,00	6130773,00	0,09	0,88	60,43	9,71674859
1900000,00	6184729,00	0,09	0,88	60,97	9,7600341
2000000,00	6157439,00	0,09	0,88	60,69	9,73816509
2100000,00	5122814,00	0,09	0,88	50,35	8,86937674
2200000,00	1787489,00	0,09	0,88	16,99	5,15280415
2300000,00	65520,00	0,09	0,88	-0,23	0,59529404
2400000,00	-156352,00	0,09	0,88	0,68	1,03192781
2500000,00	-71261,00	0,09	0,88	0,71	1,05520288
2600000,00	-76520,00	0,09	0,88	0,77	1,09344639

DISTANCE 1,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-70153,00	0,09	0,88	-0,18	0,53102201
100000,00	-202884,00	0,09	0,88	1,15	1,3386327
200000,00	133230,00	0,09	0,88	0,45	0,83880495
300000,00	1270928,00	0,09	0,88	11,83	4,29885159
400000,00	4090493,00	0,09	0,88	40,02	7,9079598
500000,00	5956960,00	0,09	0,88	58,69	9,57597906
600000,00	6181456,00	0,09	0,88	60,93	9,75741385
700000,00	6166085,00	0,09	0,88	60,78	9,74509893
800000,00	6086087,00	0,09	0,88	59,98	9,6807533
900000,00	6172122,00	0,09	0,88	60,84	9,7499375
1000000,00	6078676,00	0,09	0,88	59,90	9,67477067
1100000,00	6040282,00	0,09	0,88	59,52	9,64371719
1200000,00	6163933,00	0,09	0,88	60,76	9,74337355
1300000,00	6117822,00	0,09	0,88	60,30	9,70633009
1400000,00	6136299,00	0,09	0,88	60,48	9,72119061
1500000,00	6028031,00	0,09	0,88	59,40	9,63378738
1600000,00	6041682,00	0,09	0,88	59,53	9,64485128
1700000,00	6081987,00	0,09	0,88	59,94	9,67744397
1800000,00	6132110,00	0,09	0,88	60,44	9,71782351
1900000,00	6179864,00	0,09	0,88	60,92	9,75613909
2000000,00	6102388,00	0,09	0,88	60,14	9,6938995
2100000,00	4689574,00	0,09	0,88	46,01	8,47917854
2200000,00	1763548,00	0,09	0,88	16,75	5,11637689
2300000,00	286680,00	0,09	0,88	1,98	1,76103663
2400000,00	-127038,00	0,09	0,88	0,39	0,77900177
2500000,00	-81155,00	0,09	0,88	0,81	1,12607587
2600000,00	-74877,00	0,09	0,88	0,75	1,08164371

DISTANCE 2 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-82836,00	0,10	0,98	-0,15	0,48676226
100000,00	-81283,00	0,10	0,98	-0,17	0,51108035
200000,00	191146,00	0,10	0,98	0,93	1,20640219
300000,00	1347169,00	0,10	0,98	12,49	4,41794812
400000,00	3811927,00	0,10	0,98	37,14	7,61774963
500000,00	5650352,00	0,10	0,98	55,52	9,31426326
600000,00	6128646,00	0,10	0,98	60,31	9,70715426
700000,00	6150333,00	0,10	0,98	60,52	9,7245927
800000,00	6129346,00	0,10	0,98	60,31	9,70771761
900000,00	6078943,00	0,10	0,98	59,81	9,66706959
1000000,00	6078370,00	0,10	0,98	59,80	9,6666065
1100000,00	6067648,00	0,10	0,98	59,70	9,65793715
1200000,00	6158534,00	0,10	0,98	60,61	9,73117895
1300000,00	6138452,00	0,10	0,98	60,40	9,7150431
1400000,00	6141801,00	0,10	0,98	60,44	9,71773588
1500000,00	6118688,00	0,10	0,98	60,21	9,69913656
1600000,00	6128022,00	0,10	0,98	60,30	9,70665204
1700000,00	6134695,00	0,10	0,98	60,37	9,71202138
1800000,00	6098109,00	0,10	0,98	60,00	9,68254631
1900000,00	6141775,00	0,10	0,98	60,44	9,71771498
2000000,00	5837218,00	0,10	0,98	57,39	9,46970333
2100000,00	4627048,00	0,10	0,98	45,29	8,41227526
2200000,00	2150931,00	0,10	0,98	20,53	5,6636602
2300000,00	459347,00	0,10	0,98	3,61	2,37614117
2400000,00	-171634,00	0,10	0,98	0,74	1,0726282
2500000,00	-71413,00	0,10	0,98	0,71	1,05632766
2600000,00	-85803,00	0,10	0,98	0,86	1,15787386

DISTANCE 2,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-74431,00	0,10	0,98	-0,24	0,60684893
100000,00	-113297,00	0,10	0,98	0,15	0,48889224
200000,00	289087,00	0,10	0,98	1,91	1,72792777
300000,00	1656489,00	0,10	0,98	15,58	4,93471282
400000,00	3608914,00	0,10	0,98	35,11	7,40662077
500000,00	5338306,00	0,10	0,98	52,40	9,04874473
600000,00	6025993,00	0,10	0,98	59,28	9,6241826
700000,00	6116255,00	0,10	0,98	60,18	9,69717662
800000,00	6070297,00	0,10	0,98	59,72	9,66007974
900000,00	6028579,00	0,10	0,98	59,31	9,62628157
1000000,00	6039798,00	0,10	0,98	59,42	9,63538239
1100000,00	6118739,00	0,10	0,98	60,21	9,69917764
1200000,00	6121018,00	0,10	0,98	60,23	9,70101316
1300000,00	6149085,00	0,10	0,98	60,51	9,72359003
1400000,00	6127436,00	0,10	0,98	60,29	9,70618038
1500000,00	6140757,00	0,10	0,98	60,43	9,71689653
1600000,00	6055894,00	0,10	0,98	59,58	9,64842442
1700000,00	6129232,00	0,10	0,98	60,31	9,70762587
1800000,00	6213649,00	0,10	0,98	61,16	9,77532688
1900000,00	6172313,00	0,10	0,98	60,74	9,74223489
2000000,00	5886920,00	0,10	0,98	57,89	9,51061907
2100000,00	4536658,00	0,10	0,98	44,39	8,32790677
2200000,00	2566024,00	0,10	0,98	24,68	6,20990137
2300000,00	836517,00	0,10	0,98	7,39	3,39695866
2400000,00	92416,00	0,10	0,98	-0,06	0,29538111
2500000,00	-48771,00	0,10	0,98	0,49	0,87295296
2600000,00	-72496,00	0,10	0,98	0,72	1,06430729

DISTANCE 2,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-75692,00	0,11	1,08	-0,32	0,70829902
100000,00	191464,00	0,11	1,08	0,84	1,14335034
200000,00	766095,00	0,11	1,08	6,58	3,20715752
300000,00	2124596,00	0,11	1,08	20,17	5,61359399
400000,00	3479340,00	0,11	1,08	33,72	7,25812045
500000,00	5044751,00	0,11	1,08	49,37	8,78293
600000,00	5892065,00	0,11	1,08	57,84	9,50679445
700000,00	6136745,00	0,11	1,08	60,29	9,70578516
800000,00	6107379,00	0,11	1,08	60,00	9,68211867
900000,00	6078574,00	0,11	1,08	59,71	9,65884795
1000000,00	6123667,00	0,11	1,08	60,16	9,69525254
1100000,00	6123667,00	0,11	1,08	60,16	9,69525254
1200000,00	6047349,00	0,11	1,08	59,40	9,63355869
1300000,00	6118891,00	0,11	1,08	60,11	9,69140325
1400000,00	6113658,00	0,11	1,08	60,06	9,68718387
1500000,00	6095613,00	0,11	1,08	59,88	9,67262002
1600000,00	6058632,00	0,11	1,08	59,51	9,6427045
1700000,00	6081605,00	0,11	1,08	59,74	9,66129925
1800000,00	6135102,00	0,11	1,08	60,27	9,70446257
1900000,00	6042001,00	0,11	1,08	59,34	9,62922067
2000000,00	5299059,00	0,11	1,08	51,91	9,00629901
2100000,00	4033507,00	0,11	1,08	39,26	7,83193283
2200000,00	2250871,00	0,11	1,08	21,43	5,78666436
2300000,00	850219,00	0,11	1,08	7,42	3,40592086
2400000,00	105736,00	0,11	1,08	-0,02	0,17958285
2500000,00	-79971,00	0,11	1,08	0,80	1,11783133
2600000,00	-96704,00	0,11	1,08	0,97	1,2292274

DISTANCE 2,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-68663,00	0,11	1,08	-0,39	0,78199465
100000,00	124468,00	0,11	1,08	0,17	0,51033078
200000,00	983370,00	0,11	1,08	8,76	3,69875401
300000,00	2329315,00	0,11	1,08	22,22	5,89161878
400000,00	3447504,00	0,11	1,08	33,40	7,22377152
500000,00	4864151,00	0,11	1,08	47,56	8,62078792
600000,00	5912567,00	0,11	1,08	58,05	9,52362769
700000,00	6028362,00	0,11	1,08	59,21	9,61814854
800000,00	6135803,00	0,11	1,08	60,28	9,70502689
900000,00	6123705,00	0,11	1,08	60,16	9,69528316
1000000,00	6060720,00	0,11	1,08	59,53	9,64439604
1100000,00	6033099,00	0,11	1,08	59,25	9,62199547
1200000,00	6098096,00	0,11	1,08	59,90	9,67462532
1300000,00	6115759,00	0,11	1,08	60,08	9,68887813
1400000,00	6049043,00	0,11	1,08	59,41	9,63493238
1500000,00	6091232,00	0,11	1,08	59,83	9,66908088
1600000,00	6085107,00	0,11	1,08	59,77	9,66413068
1700000,00	6136962,00	0,11	1,08	60,29	9,70595983
1800000,00	6149289,00	0,11	1,08	60,41	9,71587699
1900000,00	5981779,00	0,11	1,08	58,74	9,580236
2000000,00	5356695,00	0,11	1,08	52,49	9,05615726
2100000,00	3758187,00	0,11	1,08	36,50	7,55230408
2200000,00	2483301,00	0,11	1,08	23,76	6,09238895
2300000,00	675909,00	0,11	1,08	5,68	2,97937965
2400000,00	62146,00	0,11	1,08	-0,46	0,8445968
2500000,00	-89789,00	0,11	1,08	0,90	1,18446322
2600000,00	-64715,00	0,11	1,08	0,65	1,00557042

DISTANCE 3 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-76609,00	0,10	0,98	-0,21	0,57813007
100000,00	50863,00	0,10	0,98	-0,47	0,85820489
200000,00	965084,00	0,10	0,98	8,67	3,68078626
300000,00	2112778,00	0,10	0,98	20,15	5,61078482
400000,00	3545178,00	0,10	0,98	34,47	7,33908416
500000,00	4681730,00	0,10	0,98	45,84	8,46290619
600000,00	5754698,00	0,10	0,98	56,57	9,40137789
700000,00	6040982,00	0,10	0,98	59,43	9,63634234
800000,00	6073111,00	0,10	0,98	59,75	9,66235527
900000,00	6109710,00	0,10	0,98	60,12	9,69190223
1000000,00	6116969,00	0,10	0,98	60,19	9,69775183
1100000,00	6131167,00	0,10	0,98	60,33	9,70918299
1200000,00	6074321,00	0,10	0,98	59,76	9,66333357
1300000,00	6059753,00	0,10	0,98	59,62	9,65154861
1400000,00	6048177,00	0,10	0,98	59,50	9,6421738
1500000,00	6073569,00	0,10	0,98	59,76	9,66272558
1600000,00	6016544,00	0,10	0,98	59,19	9,61650924
1700000,00	6083044,00	0,10	0,98	59,85	9,67038327
1800000,00	6107061,00	0,10	0,98	60,09	9,68976667
1900000,00	5606698,00	0,10	0,98	55,09	9,27757545
2000000,00	5019486,00	0,10	0,98	49,21	8,76916294
2100000,00	3752393,00	0,10	0,98	36,54	7,55644696
2200000,00	2386799,00	0,10	0,98	22,89	5,98017428
2300000,00	930522,00	0,10	0,98	8,33	3,60668217
2400000,00	447427,00	0,10	0,98	3,49	2,33662082
2500000,00	-75896,00	0,10	0,98	0,76	1,08897888
2600000,00	-63442,00	0,10	0,98	0,63	0,99563108

DISTANCE 3,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-72763,00	0,10	0,98	-0,25	0,62795551
100000,00	453285,00	0,10	0,98	3,55	2,35612566
200000,00	1527897,00	0,10	0,98	14,30	4,72674736
300000,00	1788750,00	0,10	0,98	16,91	5,13984132
400000,00	3250336,00	0,10	0,98	31,52	7,01820846
500000,00	4517964,00	0,10	0,98	44,20	8,31035123
600000,00	5587227,00	0,10	0,98	54,89	9,26116471
700000,00	5929059,00	0,10	0,98	58,31	9,54517139
800000,00	6090073,00	0,10	0,98	59,92	9,67606018
900000,00	6191363,00	0,10	0,98	60,93	9,75749952
1000000,00	6061828,00	0,10	0,98	59,64	9,65322809
1100000,00	6111276,00	0,10	0,98	60,13	9,69316447
1200000,00	6035111,00	0,10	0,98	59,37	9,63158135
1300000,00	6116625,00	0,10	0,98	60,19	9,6974747
1400000,00	6091703,00	0,10	0,98	59,94	9,67737616
1500000,00	6030756,00	0,10	0,98	59,33	9,62804822
1600000,00	6132275,00	0,10	0,98	60,34	9,7100745
1700000,00	6169842,00	0,10	0,98	60,72	9,74025314
1800000,00	6150970,00	0,10	0,98	60,53	9,72510443
1900000,00	5610990,00	0,10	0,98	55,13	9,28118897
2000000,00	5103050,00	0,10	0,98	50,05	8,84329725
2100000,00	3634141,00	0,10	0,98	35,36	7,43318257
2200000,00	2285827,00	0,10	0,98	21,88	5,84677662
2300000,00	1502746,00	0,10	0,98	14,05	4,68499266
2400000,00	385232,00	0,10	0,98	2,87	2,11849003
2500000,00	-81856,00	0,10	0,98	0,82	1,13092882
2600000,00	-67771,00	0,10	0,98	0,68	1,0290393

DISTANCE 3,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-47944,00	0,10	0,98	-0,50	0,88437831
100000,00	727522,00	0,10	0,98	6,30	3,13628463
200000,00	1471521,00	0,10	0,98	13,74	4,63263053
300000,00	2101623,00	0,10	0,98	20,04	5,59523095
400000,00	2920271,00	0,10	0,98	28,22	6,64063132
500000,00	4518295,00	0,10	0,98	44,20	8,31066239
600000,00	5068399,00	0,10	0,98	49,70	8,81263209
700000,00	6059511,00	0,10	0,98	59,62	9,65135272
800000,00	6133753,00	0,10	0,98	60,36	9,7112636
900000,00	6141495,00	0,10	0,98	60,43	9,71748987
1000000,00	6139177,00	0,10	0,98	60,41	9,71562611
1100000,00	6096848,00	0,10	0,98	59,99	9,6815288
1200000,00	6179138,00	0,10	0,98	60,81	9,74770646
1300000,00	6128060,00	0,10	0,98	60,30	9,70668262
1400000,00	6082815,00	0,10	0,98	59,85	9,67019826
1500000,00	6098975,00	0,10	0,98	60,01	9,68324503
1600000,00	6162953,00	0,10	0,98	60,65	9,73472602
1700000,00	6180565,00	0,10	0,98	60,83	9,74885009
1800000,00	5960742,00	0,10	0,98	58,63	9,57106806
1900000,00	5808272,00	0,10	0,98	57,10	9,44579271
2000000,00	4922055,00	0,10	0,98	48,24	8,68192717
2100000,00	3811354,00	0,10	0,98	37,13	7,61716196
2200000,00	2779275,00	0,10	0,98	26,81	6,47262867
2300000,00	1571894,00	0,10	0,98	14,74	4,79891589
2400000,00	861578,00	0,10	0,98	7,64	3,45411439
2500000,00	-80136,00	0,10	0,98	0,80	1,11898391
2600000,00	-71694,00	0,10	0,98	0,72	1,05840387

DISTANCE 3,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-69032,00	0,09	0,88	-0,19	0,54726593
100000,00	285177,00	0,09	0,88	1,97	1,75435619
200000,00	1790265,00	0,09	0,88	17,02	5,15701131
300000,00	2766006,00	0,09	0,88	26,78	6,46844021
400000,00	3127003,00	0,09	0,88	30,39	6,89066738
500000,00	3878897,00	0,09	0,88	37,91	7,69607956
600000,00	5042968,00	0,09	0,88	49,55	8,79876412
700000,00	5897961,00	0,09	0,88	58,10	9,52772353
800000,00	6078345,00	0,09	0,88	59,90	9,67450338
900000,00	6108857,00	0,09	0,88	60,21	9,69911159
1000000,00	6094263,00	0,09	0,88	60,06	9,68734919
1100000,00	6178922,00	0,09	0,88	60,91	9,75538473
1200000,00	6097357,00	0,09	0,88	60,09	9,68984407
1300000,00	6134682,00	0,09	0,88	60,46	9,71989101
1400000,00	6083031,00	0,09	0,88	59,95	9,67828675
1500000,00	6151645,00	0,09	0,88	60,63	9,73351571
1600000,00	6138681,00	0,09	0,88	60,50	9,72310473
1700000,00	6171332,00	0,09	0,88	60,83	9,74930446
1800000,00	6022415,00	0,09	0,88	59,34	9,62923202
1900000,00	5784611,00	0,09	0,88	56,96	9,43432148
2000000,00	4444206,00	0,09	0,88	43,56	8,25000568
2100000,00	3490789,00	0,09	0,88	34,03	7,2914644
2200000,00	2938240,00	0,09	0,88	28,50	6,67322074
2300000,00	1807278,00	0,09	0,88	17,19	5,18272069
2400000,00	776104,00	0,09	0,88	6,88	3,27849051
2500000,00	-84708,00	0,09	0,88	0,85	1,15046186
2600000,00	-76405,00	0,09	0,88	0,76	1,09262442

DISTANCE 4 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-52006,00	0,10	0,98	-0,46	0,84773596
100000,00	471432,00	0,10	0,98	3,73	2,41554859
200000,00	1136171,00	0,10	0,98	10,38	4,02758263
300000,00	2203575,00	0,10	0,98	21,06	5,73581811
400000,00	3484689,00	0,10	0,98	33,87	7,27440827
500000,00	4018722,00	0,10	0,98	39,21	7,82695862
600000,00	4812742,00	0,10	0,98	47,15	8,58299736
700000,00	5853543,00	0,10	0,98	57,56	9,48316189
800000,00	6151173,00	0,10	0,98	60,53	9,72526751
900000,00	6074805,00	0,10	0,98	59,77	9,66372486
1000000,00	6168072,00	0,10	0,98	60,70	9,73883335
1100000,00	6160813,00	0,10	0,98	60,63	9,73300843
1200000,00	6153606,00	0,10	0,98	60,56	9,72722179
1300000,00	6144182,00	0,10	0,98	60,46	9,71964988
1400000,00	6113874,00	0,10	0,98	60,16	9,69525818
1500000,00	6105367,00	0,10	0,98	60,07	9,68840076
1600000,00	6189606,00	0,10	0,98	60,92	9,75609265
1700000,00	6049845,00	0,10	0,98	59,52	9,64352519
1800000,00	6104285,00	0,10	0,98	60,06	9,68752823
1900000,00	5065725,00	0,10	0,98	49,68	8,81026124
2000000,00	4384303,00	0,10	0,98	42,86	8,18373291
2100000,00	3105966,00	0,10	0,98	30,08	6,85561585
2200000,00	2441646,00	0,10	0,98	23,44	6,05140221
2300000,00	1596434,00	0,10	0,98	14,98	4,8387014
2400000,00	694196,00	0,10	0,98	5,96	3,05214064
2500000,00	-20616,00	0,10	0,98	0,21	0,56756057
2600000,00	-62537,00	0,10	0,98	0,63	0,98850424

DISTANCE 4,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-73744,00	0,10	0,98	-0,24	0,61562976
100000,00	150307,00	0,10	0,98	0,52	0,90404473
200000,00	1298052,00	0,10	0,98	12,00	4,33022084
300000,00	1994679,00	0,10	0,98	18,97	5,44385979
400000,00	2861731,00	0,10	0,98	27,64	6,57139992
500000,00	4051666,00	0,10	0,98	39,54	7,85977298
600000,00	4962206,00	0,10	0,98	48,64	8,71798249
700000,00	5476335,00	0,10	0,98	53,78	9,16714156
800000,00	5900291,00	0,10	0,98	58,02	9,52159634
900000,00	6153478,00	0,10	0,98	60,55	9,72711899
1000000,00	6149441,00	0,10	0,98	60,51	9,72387606
1100000,00	6034118,00	0,10	0,98	59,36	9,63077586
1200000,00	6124138,00	0,10	0,98	60,26	9,70352545
1300000,00	6073455,00	0,10	0,98	59,75	9,66263341
1400000,00	6109837,00	0,10	0,98	60,12	9,6920046
1500000,00	6109837,00	0,10	0,98	60,12	9,6920046
1600000,00	6089870,00	0,10	0,98	59,92	9,67589628
1700000,00	6005733,00	0,10	0,98	59,08	9,60772232
1800000,00	5822560,00	0,10	0,98	57,25	9,45760276
1900000,00	5605437,00	0,10	0,98	55,07	9,27651352
2000000,00	4585088,00	0,10	0,98	44,87	8,37321623
2100000,00	3092263,00	0,10	0,98	29,94	6,83998241
2200000,00	2073034,00	0,10	0,98	19,75	5,55516933
2300000,00	1704269,00	0,10	0,98	16,06	5,00978574
2400000,00	875255,00	0,10	0,98	7,77	3,48491167
2500000,00	-68701,00	0,10	0,98	0,69	1,03607583
2600000,00	-64868,00	0,10	0,98	0,65	1,00675841

DISTANCE 4,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-69631,00	0,09	0,88	-0,19	0,53864703
100000,00	637171,00	0,09	0,88	5,49	2,92876627
200000,00	1273589,00	0,09	0,88	11,85	4,30368483
300000,00	1995316,00	0,09	0,88	19,07	5,45881741
400000,00	2610098,00	0,09	0,88	25,22	6,27731282
500000,00	3456278,00	0,09	0,88	33,68	7,25439307
600000,00	4794531,00	0,09	0,88	47,06	8,575338
700000,00	5310252,00	0,09	0,88	52,22	9,03297086
800000,00	6084165,00	0,09	0,88	59,96	9,67920209
900000,00	6241219,00	0,09	0,88	61,53	9,80514772
1000000,00	6134033,00	0,09	0,88	60,46	9,71936935
1100000,00	6059205,00	0,09	0,88	59,71	9,65903479
1200000,00	6113148,00	0,09	0,88	60,25	9,70256731
1300000,00	6092557,00	0,09	0,88	60,04	9,68597327
1400000,00	6166391,00	0,09	0,88	60,78	9,74534424
1500000,00	6102439,00	0,09	0,88	60,14	9,6939406
1600000,00	6130085,00	0,09	0,88	60,42	9,7161954
1700000,00	6064897,00	0,09	0,88	59,77	9,66363755
1800000,00	5628283,00	0,09	0,88	55,40	9,30396673
1900000,00	4829055,00	0,09	0,88	47,41	8,60673337
2000000,00	4339834,00	0,09	0,88	42,52	8,15056938
2100000,00	3159476,00	0,09	0,88	30,71	6,92738677
2200000,00	2828685,00	0,09	0,88	27,40	6,54370523
2300000,00	2042841,00	0,09	0,88	19,55	5,52641526
2400000,00	907893,00	0,09	0,88	8,20	3,57878515
2500000,00	-77819,00	0,09	0,88	0,78	1,10268848
2600000,00	-68917,00	0,09	0,88	0,69	1,03770329

DISTANCE 4,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-71375,00	0,08	0,78	-0,07	0,33130896
100000,00	224969,00	0,08	0,78	1,47	1,51332106
200000,00	1174489,00	0,08	0,78	10,96	4,13840436
300000,00	2059523,00	0,08	0,78	19,81	5,56372599
400000,00	2248961,00	0,08	0,78	21,71	5,82365999
500000,00	3635580,00	0,08	0,78	35,57	7,4552624
600000,00	4421017,00	0,08	0,78	43,43	8,23731696
700000,00	5212197,00	0,08	0,78	51,34	8,95631499
800000,00	5355396,00	0,08	0,78	52,77	9,08036687
900000,00	6050355,00	0,08	0,78	59,72	9,65980315
1000000,00	6053271,00	0,08	0,78	59,75	9,66216122
1100000,00	6107418,00	0,08	0,78	60,29	9,70584392
1200000,00	6082585,00	0,08	0,78	60,04	9,68583453
1300000,00	6054799,00	0,08	0,78	59,76	9,66339663
1400000,00	6099993,00	0,08	0,78	60,22	9,6998655
1500000,00	6193426,00	0,08	0,78	61,15	9,77482896
1600000,00	6087323,00	0,08	0,78	60,09	9,68965541
1700000,00	5954859,00	0,08	0,78	58,76	9,58225818
1800000,00	5695432,00	0,08	0,78	56,17	9,36835765
1900000,00	4963747,00	0,08	0,78	48,85	8,73690717
2000000,00	4017767,00	0,08	0,78	39,39	7,8455471
2100000,00	3647626,00	0,08	0,78	35,69	7,46787495
2200000,00	2514169,00	0,08	0,78	24,36	6,16918881
2300000,00	1054072,00	0,08	0,78	9,76	3,90446859
2400000,00	789004,00	0,08	0,78	7,11	3,33214458
2500000,00	-81537,00	0,08	0,78	0,82	1,12872301
2600000,00	-81665,00	0,08	0,78	0,82	1,12960862

DISTANCE 5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-70611,00	0,07	0,69	0,02	0,17726216
100000,00	706701,00	0,07	0,69	6,38	3,15758264
200000,00	535028,00	0,07	0,69	4,66	2,69961803
300000,00	1686568,00	0,07	0,69	16,18	5,02799662
400000,00	2453960,00	0,07	0,69	23,85	6,10501843
500000,00	3870798,00	0,07	0,69	38,02	7,7077457
600000,00	4276951,00	0,07	0,69	42,08	8,10897554
700000,00	5273602,00	0,07	0,69	52,05	9,01821248
800000,00	5547597,00	0,07	0,69	54,79	9,2525309
900000,00	6032781,00	0,07	0,69	59,64	9,65351377
1000000,00	6175050,00	0,07	0,69	61,06	9,76797222
1100000,00	6191809,00	0,07	0,69	61,23	9,78136701
1200000,00	6112435,00	0,07	0,69	60,44	9,71776321
1300000,00	6115415,00	0,07	0,69	60,47	9,72015866
1400000,00	6081783,00	0,07	0,69	60,13	9,69308952
1500000,00	6165410,00	0,07	0,69	60,97	9,76025903
1600000,00	6015819,00	0,07	0,69	59,47	9,63977681
1700000,00	5705581,00	0,07	0,69	56,37	9,38497886
1800000,00	5156649,00	0,07	0,69	50,88	8,91632018
1900000,00	4696107,00	0,07	0,69	46,28	8,50322273
2000000,00	3740244,00	0,07	0,69	36,72	7,57426152
2100000,00	2643182,00	0,07	0,69	25,75	6,34254237
2200000,00	2270393,00	0,07	0,69	22,02	5,86540839
2300000,00	1847545,00	0,07	0,69	17,79	5,27219268
2400000,00	1456622,00	0,07	0,69	13,88	4,65702091
2500000,00	-91254,00	0,07	0,69	0,91	1,19408699
2600000,00	-92120,00	0,07	0,69	0,92	1,19973956

DISTANCE 5,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-95099,00	0,08	0,78	0,17	0,51080512
100000,00	547164,00	0,08	0,78	4,69	2,7063698
200000,00	643475,00	0,08	0,78	5,65	2,97141328
300000,00	1470974,00	0,08	0,78	13,93	4,66465098
400000,00	2095319,00	0,08	0,78	20,17	5,61376517
500000,00	3205855,00	0,08	0,78	31,27	6,99045666
600000,00	4141673,00	0,08	0,78	40,63	7,96797594
700000,00	5159425,00	0,08	0,78	50,81	8,91016361
800000,00	5879369,00	0,08	0,78	58,01	9,52051157
900000,00	6012100,00	0,08	0,78	59,34	9,62881418
1000000,00	6029381,00	0,08	0,78	59,51	9,64282521
1100000,00	6141597,00	0,08	0,78	60,63	9,73331666
1200000,00	6041173,00	0,08	0,78	59,63	9,65237422
1300000,00	6109035,00	0,08	0,78	60,31	9,7071454
1400000,00	6086508,00	0,08	0,78	60,08	9,68899827
1500000,00	6156242,00	0,08	0,78	60,78	9,74506446
1600000,00	6074474,00	0,08	0,78	59,96	9,67929007
1700000,00	6014163,00	0,08	0,78	59,36	9,63048788
1800000,00	5820090,00	0,08	0,78	57,42	9,47174251
1900000,00	4290730,00	0,08	0,78	42,12	8,11280816
2000000,00	4150944,00	0,08	0,78	40,73	7,97706086
2100000,00	3349754,00	0,08	0,78	32,71	7,14946895
2200000,00	2419144,00	0,08	0,78	23,41	6,0476545
2300000,00	1775417,00	0,08	0,78	16,97	5,14935827
2400000,00	1188192,00	0,08	0,78	11,10	4,1641926
2500000,00	-95876,00	0,08	0,78	0,96	1,22395363
2600000,00	-87637,00	0,08	0,78	0,88	1,17018295

DISTANCE 5,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-62232,00	0,08	0,78	-0,16	0,50261815
100000,00	648632,00	0,08	0,78	5,70	2,98494137
200000,00	963785,00	0,08	0,78	8,85	3,71942746
300000,00	1677667,00	0,08	0,78	15,99	4,99885456
400000,00	2725141,00	0,08	0,78	26,47	6,43081085
500000,00	3168033,00	0,08	0,78	30,90	6,94805841
600000,00	3890269,00	0,08	0,78	38,12	7,71754191
700000,00	4794391,00	0,08	0,78	47,16	8,58413417
800000,00	5425105,00	0,08	0,78	53,47	9,14014582
900000,00	6038766,00	0,08	0,78	59,60	9,65042583
1000000,00	6102630,00	0,08	0,78	60,24	9,70198916
1100000,00	6147200,00	0,08	0,78	60,69	9,7378129
1200000,00	6130785,00	0,08	0,78	60,52	9,72463447
1300000,00	6098185,00	0,08	0,78	60,20	9,69840918
1400000,00	6102821,00	0,08	0,78	60,24	9,70214297
1500000,00	6156089,00	0,08	0,78	60,78	9,7449418
1600000,00	5983066,00	0,08	0,78	59,05	9,60522807
1700000,00	5585253,00	0,08	0,78	55,07	9,27602168
1800000,00	5853938,00	0,08	0,78	57,76	9,49962006
1900000,00	4280097,00	0,08	0,78	42,02	8,10256229
2000000,00	3871244,00	0,08	0,78	37,93	7,69825873
2100000,00	3002485,00	0,08	0,78	29,24	6,75935116
2200000,00	2284541,00	0,08	0,78	22,06	5,87119691
2300000,00	1694756,00	0,08	0,78	16,16	5,02549127
2400000,00	971999,00	0,08	0,78	8,94	3,73664079
2500000,00	-59035,00	0,08	0,78	0,59	0,96042796
2600000,00	-69885,00	0,08	0,78	0,70	1,04496561

DISTANCE 5,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-66918,00	0,10	0,00	0,67	1,02254279
100000,00	511558,00	0,10	0,98	4,14	2,54201569
200000,00	900151,00	0,10	0,98	8,02	3,5402838
300000,00	1601489,00	0,10	0,98	15,03	4,84685626
400000,00	2370206,00	0,10	0,98	22,72	5,95845775
500000,00	3271450,00	0,10	0,98	31,73	7,04167283
600000,00	3778231,00	0,10	0,98	36,80	7,58311344
700000,00	4715527,00	0,10	0,98	46,18	8,49404847
800000,00	5284796,00	0,10	0,98	51,87	9,00242676
900000,00	5823834,00	0,10	0,98	57,26	9,4586551
1000000,00	5925875,00	0,10	0,98	58,28	9,54256501
1100000,00	6098402,00	0,10	0,98	60,00	9,68278272
1200000,00	6017449,00	0,10	0,98	59,19	9,61724444
1300000,00	6089640,00	0,10	0,98	59,92	9,67571057
1400000,00	6094734,00	0,10	0,98	59,97	9,67982276
1500000,00	6110780,00	0,10	0,98	60,13	9,6927647
1600000,00	6027420,00	0,10	0,98	59,29	9,6253409
1700000,00	5868748,00	0,10	0,98	57,71	9,49567994
1800000,00	5368309,00	0,10	0,98	52,70	9,07461173
1900000,00	4974126,00	0,10	0,98	48,76	8,7286579
2000000,00	3637553,00	0,10	0,98	35,40	7,43676782
2100000,00	3081006,00	0,10	0,98	29,83	6,82711277
2200000,00	2594715,00	0,10	0,98	24,97	6,2458924
2300000,00	1821414,00	0,10	0,98	17,23	5,18925272
2400000,00	1186065,00	0,10	0,98	10,88	4,12322879
2500000,00	-88554,00	0,10	0,98	0,89	1,17628919
2600000,00	-100181,00	0,10	0,98	1,00	1,25113074

DISTANCE 6,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-115882,00	0,12	1,18	-0,02	0,16384062
100000,00	156266,00	0,12	1,18	0,39	0,77727489
200000,00	1201754,00	0,12	1,18	10,84	4,11581174
300000,00	1491374,00	0,12	1,18	13,74	4,63305717
400000,00	2190561,00	0,12	1,18	20,73	5,69122268
500000,00	2770590,00	0,12	1,18	26,53	6,438398
600000,00	4150969,00	0,12	1,18	40,33	7,9386013
700000,00	3883736,00	0,12	1,18	37,66	7,6711065
800000,00	5647830,00	0,12	1,18	55,30	9,29568953
900000,00	5963429,00	0,12	1,18	58,46	9,55725265
1000000,00	6050507,00	0,12	1,18	59,33	9,62817074
1100000,00	5977844,00	0,12	1,18	58,60	9,56902882
1200000,00	6068068,00	0,12	1,18	59,50	9,64240958
1300000,00	6058084,00	0,12	1,18	59,40	9,63431692
1400000,00	6022186,00	0,12	1,18	59,05	9,605163
1500000,00	5973566,00	0,12	1,18	58,56	9,56553547
1600000,00	5953394,00	0,12	1,18	58,36	9,54904609
1700000,00	5373390,00	0,12	1,18	52,56	9,06210344
1800000,00	5231069,00	0,12	1,18	51,13	8,9385655
1900000,00	4458469,00	0,12	1,18	43,41	8,23565894
2000000,00	3641374,00	0,12	1,18	35,24	7,42017309
2100000,00	2731585,00	0,12	1,18	26,14	6,39089318
2200000,00	1951611,00	0,12	1,18	18,34	5,35316933
2300000,00	1516232,00	0,12	1,18	13,99	4,67478609
2400000,00	1069506,00	0,12	1,18	9,52	3,85662174
2500000,00	-105389,00	0,12	1,18	1,05	1,28323931
2600000,00	-97150,00	0,12	1,18	0,97	1,23205874

DISTANCE 6,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0,00	-72598,00	0,13	1,27	-0,55	0,92535466
100000,00	423601,00	0,13	1,27	2,96	2,15131137
200000,00	1142781,00	0,13	1,27	10,15	3,98313044
300000,00	1389804,00	0,13	1,27	12,62	4,44129063
400000,00	1931656,00	0,13	1,27	18,04	5,30956684
500000,00	2816294,00	0,13	1,27	26,89	6,48181832
600000,00	4339147,00	0,13	1,27	42,12	8,11224672
700000,00	4402055,00	0,13	1,27	42,75	8,17260573
800000,00	5486663,00	0,13	1,27	53,59	9,15087342
900000,00	5917547,00	0,13	1,27	57,90	9,51162693
1000000,00	5981907,00	0,13	1,27	58,55	9,56434378
1100000,00	6137356,00	0,13	1,27	60,10	9,69048825
1200000,00	6023026,00	0,13	1,27	58,96	9,59787249
1300000,00	6098796,00	0,13	1,27	59,71	9,65935104
1400000,00	5996679,00	0,13	1,27	58,69	9,57640248
1500000,00	6144755,00	0,13	1,27	60,17	9,69645151
1600000,00	5856192,00	0,13	1,27	57,29	9,46109798
1700000,00	5591773,00	0,13	1,27	54,64	9,24017468
1800000,00	5046381,00	0,13	1,27	49,19	8,76693094
1900000,00	4348379,00	0,13	1,27	42,21	8,12113273
2000000,00	3739493,00	0,13	1,27	36,12	7,51258631
2100000,00	2838975,00	0,13	1,27	27,12	6,5090982
2200000,00	2462352,00	0,13	1,27	23,35	6,04016763
2300000,00	1603781,00	0,13	1,27	14,76	4,80296295
2400000,00	1729331,00	0,13	1,27	16,02	5,00301628
2500000,00	-43092,00	0,13	1,27	0,43	0,82055621
2600000,00	-61952,00	0,13	1,27	0,62	0,98386991

1.3. Tables of measures at 25 m/s:

DISTANCE 0 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-123217	0,7	6,86	-5,62783	2,96538098
100000	-268441	0,7	6,86	-4,17559	2,55428256
200000	-507913	0,7	6,86	-1,78087	1,66811552
300000	-1020055	0,7	6,86	3,34055	2,28464644
400000	37497402	0,7	6,86	368,11402	23,9828721
500000	37258504	0,7	6,86	365,72504	23,9049237
600000	37321221	0,7	6,86	366,35221	23,9254118
700000	37288544	0,7	6,86	366,02544	23,9147392
800000	37332096	0,7	6,86	366,46096	23,9289626
900000	37186032	0,7	6,86	365,00032	23,8812269
1000000	36951195	0,7	6,86	362,65195	23,8042784
1100000	37097578	0,7	6,86	364,11578	23,8522726
1200000	37039853	0,7	6,86	363,53853	23,833358
1300000	37091478	0,7	6,86	364,05478	23,8502745
1400000	37214022	0,7	6,86	365,28022	23,8903818
1500000	37010882	0,7	6,86	363,24882	23,8238595
1600000	37150312	0,7	6,86	364,64312	23,8695386
1700000	37428853	0,7	6,86	367,42853	23,9605317
1800000	37392050	0,7	6,86	367,0605	23,9485288
1900000	37392610	0,7	6,86	367,0661	23,9487115
2000000	37264616	0,7	6,86	365,78616	23,9069211
2100000	37416819	0,7	6,86	367,30819	23,9566076
2200000	-776598	0,7	6,86	0,90598	1,18978727
2300000	-291491	0,7	6,86	-3,94509	2,48278133
2400000	-16541	0,7	6,86	-6,69459	3,23423822
2500000	-78978	0,7	6,86	0,78978	1,11086959
2600000	-83944	0,7	6,86	0,83944	1,14526198

DISTANCE 0,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-77055	0,3	2,94	-2,16945	1,84113162
100000	-754669	0,3	2,94	4,60669	2,68290013
200000	-594444	0,3	2,94	3,00444	2,16666506
300000	-794235	0,3	2,94	5,00235	2,79574174
400000	37500892	0,3	2,94	372,06892	24,1113601
500000	37446948	0,3	2,94	371,52948	24,093875
600000	36638437	0,3	2,94	363,44437	23,8302713
700000	37241783	0,3	2,94	369,47783	24,0272576
800000	37140188	0,3	2,94	368,46188	23,9942011
900000	36801196	0,3	2,94	365,07196	23,8835705
1000000	36677035	0,3	2,94	363,83035	23,8429218
1100000	36966044	0,3	2,94	366,72044	23,9374328
1200000	36844608	0,3	2,94	365,50608	23,8977666
1300000	36619768	0,3	2,94	363,25768	23,82415
1400000	36924733	0,3	2,94	366,30733	23,9239462
1500000	36970743	0,3	2,94	366,76743	23,9389663
1600000	36931864	0,3	2,94	366,37864	23,9262748
1700000	36827875	0,3	2,94	365,33875	23,8922958
1800000	36856273	0,3	2,94	365,62273	23,9015798
1900000	37179575	0,3	2,94	368,85575	24,0070221
2000000	37140990	0,3	2,94	368,4699	23,9944623
2100000	37224630	0,3	2,94	369,3063	24,0216797
2200000	-89509	0,3	2,94	-2,04491	1,78750437
2300000	-78392	0,3	2,94	-2,15608	1,83544954
2400000	-86988	0,3	2,94	-2,07012	1,79848895
2500000	-91699	0,3	2,94	0,91699	1,19699494
2600000	-48822	0,3	2,94	0,48822	0,87340927

DISTANCE 0,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-53432	0,4	3,92	-3,38568	2,30002717
100000	-645089	0,4	3,92	2,53089	1,9885964
200000	-789167	0,4	3,92	3,97167	2,49113114
300000	-503914	0,4	3,92	1,11914	1,32236767
400000	36859252	0,4	3,92	364,67252	23,8705009
500000	37178187	0,4	3,92	367,86187	23,9746569
600000	37054536	0,4	3,92	366,62536	23,9343294
700000	37124652	0,4	3,92	367,32652	23,9572053
800000	36889268	0,4	3,92	364,97268	23,8803227
900000	36625486	0,4	3,92	362,33486	23,7938694
1000000	36743381	0,4	3,92	363,51381	23,8325477
1100000	36894132	0,4	3,92	365,02132	23,8819139
1200000	37019707	0,4	3,92	366,27707	23,9229581
1300000	36661091	0,4	3,92	362,69091	23,8055571
1400000	36681899	0,4	3,92	362,89899	23,8123848
1500000	36997154	0,4	3,92	366,05154	23,9155918
1600000	36761566	0,4	3,92	363,69566	23,8385081
1700000	36910114	0,4	3,92	365,18114	23,8871415
1800000	37029627	0,4	3,92	366,37627	23,9261974
1900000	37064418	0,4	3,92	366,72418	23,9375548
2000000	37053797	0,4	3,92	366,61797	23,9340882
2100000	36888669	0,4	3,92	364,96669	23,8801267
2200000	822916	0,4	3,92	4,30916	2,59481454
2300000	-75361	0,4	3,92	-3,16639	2,22429413
2400000	-165126	0,4	3,92	-2,26874	1,88279214
2500000	-90833	0,4	3,92	0,90833	1,19132935
2600000	-66103	0,4	3,92	0,66103	1,01629689

DISTANCE 0,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-78888	0,3	2,94	-2,15112	1,83333712
100000	-449271	0,3	2,94	1,55271	1,55759731
200000	-790580	0,3	2,94	4,9658	2,78550938
300000	511278	0,3	2,94	2,17278	1,8425441
400000	31308868	0,3	2,94	310,14868	22,0137982
500000	36613655	0,3	2,94	363,19655	23,8221454
600000	37029882	0,3	2,94	367,35882	23,9582586
700000	37094191	0,3	2,94	368,00191	23,9792198
800000	36635113	0,3	2,94	363,41113	23,8291815
900000	36759974	0,3	2,94	364,65974	23,8700826
1000000	36569912	0,3	2,94	362,75912	23,8077955
1100000	36547436	0,3	2,94	362,53436	23,8004189
1200000	36720790	0,3	2,94	364,2679	23,8572545
1300000	36535313	0,3	2,94	362,41313	23,7964391
1400000	36689425	0,3	2,94	363,95425	23,8469813
1500000	36908624	0,3	2,94	366,14624	23,9186852
1600000	37083927	0,3	2,94	367,89927	23,9758756
1700000	36802253	0,3	2,94	365,08253	23,8839162
1800000	36881843	0,3	2,94	365,87843	23,9099362
1900000	37155673	0,3	2,94	368,61673	23,9992425
2000000	37011124	0,3	2,94	367,17124	23,9521411
2100000	36281349	0,3	2,94	359,87349	23,7129148
2200000	5007834	0,3	2,94	47,13834	8,58217084
2300000	-165801	0,3	2,94	-1,28199	1,41531247
2400000	-163229	0,3	2,94	-1,30771	1,42943936
2500000	-106879	0,3	2,94	1,06879	1,29227875
2600000	-91266	0,3	2,94	0,91266	1,1941655

DISTANCE 1 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-29428	0,3	2,94	-2,64572	2,03320867
100000	-667196	0,3	2,94	3,73196	2,41478519
200000	-534515	0,3	2,94	2,40515	1,93856825
300000	3680749	0,3	2,94	33,86749	7,2744727
400000	30271059	0,3	2,94	299,77059	21,6423554
500000	36949935	0,3	2,94	366,55935	23,9321747
600000	36870930	0,3	2,94	365,7693	23,9063701
700000	36551142	0,3	2,94	362,57142	23,8016353
800000	36441842	0,3	2,94	361,47842	23,7657323
900000	36616584	0,3	2,94	363,22584	23,8231059
1000000	36526348	0,3	2,94	362,32348	23,7934957
1100000	36406784	0,3	2,94	361,12784	23,7542049
1200000	36335343	0,3	2,94	360,41343	23,7306971
1300000	36263279	0,3	2,94	359,69279	23,7069607
1400000	36589664	0,3	2,94	362,95664	23,8142762
1500000	36412565	0,3	2,94	361,18565	23,7561061
1600000	36493455	0,3	2,94	361,99455	23,782693
1700000	36608714	0,3	2,94	363,14714	23,8205249
1800000	36509271	0,3	2,94	362,15271	23,7878879
1900000	36838826	0,3	2,94	365,44826	23,8958763
2000000	36920149	0,3	2,94	366,26149	23,9224493
2100000	31784322	0,3	2,94	314,90322	22,1818908
2200000	5090150	0,3	2,94	47,9615	8,65678022
2300000	-210970	0,3	2,94	-0,8303	1,13900999
2400000	-87242	0,3	2,94	-2,06758	1,79738525
2500000	-1887770	0,3	2,94	18,8777	5,4310594
2600000	5847	0,3	2,94	0,05847	0,30225713

DISTANCE 1,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-27085	0,4	3,92	-3,64915	2,38784356
100000	-489168	0,4	3,92	0,97168	1,23217288
200000	-697389	0,4	3,92	3,05389	2,18442284
300000	3073429	0,4	3,92	26,81429	6,47281454
400000	23923993	0,4	3,92	235,31993	19,1751764
500000	37220466	0,4	3,92	368,28466	23,9884302
600000	37731870	0,4	3,92	373,3987	24,1544089
700000	37716767	0,4	3,92	373,24767	24,1495235
800000	37545386	0,4	3,92	371,53386	24,094017
900000	37246622	0,4	3,92	368,54622	23,9969471
1000000	37468164	0,4	3,92	370,76164	24,0689647
1100000	37466852	0,4	3,92	370,74852	24,0685389
1200000	37109065	0,4	3,92	367,17065	23,9521218
1300000	37346295	0,4	3,92	369,54295	24,0293749
1400000	37576853	0,4	3,92	371,84853	24,1042181
1500000	37402989	0,4	3,92	370,10989	24,0478004
1600000	37166408	0,4	3,92	367,74408	23,9708182
1700000	37809168	0,4	3,92	374,17168	24,1793972
1800000	37299369	0,4	3,92	369,07369	24,0141134
1900000	37206904	0,4	3,92	368,14904	23,9840129
2000000	37788436	0,4	3,92	373,96436	24,1726977
2100000	33242560	0,4	3,92	328,5056	22,6559043
2200000	7958807	0,4	3,92	75,66807	10,8734245
2300000	123908	0,4	3,92	-2,68092	2,0466894
2400000	-199140	0,4	3,92	-1,9286	1,73592555
2500000	4853	0,4	3,92	0,04853	0,27536907
2600000	3172	0,4	3,92	0,03172	0,22262637

DISTANCE 1,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-33134	0,5	4,9	-4,56866	2,671803
100000	-672761	0,5	4,9	1,82761	1,68986408
200000	-438536	0,5	4,9	-0,51464	0,89673017
300000	6172160	0,5	4,9	56,8216	9,42251293
400000	23733001	0,5	4,9	232,43001	19,0570693
500000	37193698	0,5	4,9	367,03698	23,9477615
600000	37755301	0,5	4,9	372,65301	24,1302782
700000	37426943	0,5	4,9	369,36943	24,0237327
800000	37479918	0,5	4,9	369,89918	24,040954
900000	37609007	0,5	4,9	371,19007	24,082867
1000000	37294937	0,5	4,9	368,04937	23,9807661
1100000	37396571	0,5	4,9	369,06571	24,0138537
1200000	37320368	0,5	4,9	368,30368	23,9890496
1300000	37213526	0,5	4,9	367,23526	23,9542291
1400000	37636552	0,5	4,9	371,46552	24,091801
1500000	37451456	0,5	4,9	369,61456	24,031703
1600000	37252837	0,5	4,9	367,62837	23,9670467
1700000	37563762	0,5	4,9	370,73762	24,068185
1800000	37540967	0,5	4,9	370,50967	24,0607847
1900000	37679416	0,5	4,9	371,89416	24,1056969
2000000	37318776	0,5	4,9	368,28776	23,9885311
2100000	29106020	0,5	4,9	286,1602	21,1453378
2200000	9237322	0,5	4,9	87,47322	11,6908899
2300000	615471	0,5	4,9	1,25471	1,40017298
2400000	-554661	0,5	4,9	0,64661	1,0051508
2500000	-33898	0,5	4,9	0,33898	0,72777486
2600000	-6620	0,5	4,9	0,0662	0,32161701

DISTANCE 1,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-3335	0,65	6,37	-6,33665	3,14658793
100000	-926266	0,65	6,37	2,89266	2,12597772
200000	777174	0,65	6,37	1,40174	1,47993877
300000	7855339	0,65	6,37	72,18339	10,6201011
400000	23151137	0,65	6,37	225,14137	18,7558895
500000	36922938	0,65	6,37	362,85938	23,8110853
600000	37221319	0,65	6,37	365,84319	23,9087847
700000	37232806	0,65	6,37	365,95806	23,9125379
800000	37166624	0,65	6,37	365,29624	23,8909057
900000	37102787	0,65	6,37	364,65787	23,8700214
1000000	37039560	0,65	6,37	364,0256	23,8493186
1100000	37070377	0,65	6,37	364,33377	23,8594115
1200000	36995982	0,65	6,37	363,58982	23,8350392
1300000	36932272	0,65	6,37	362,95272	23,8141476
1400000	37035650	0,65	6,37	363,9865	23,8480378
1500000	37014829	0,65	6,37	363,77829	23,841216
1600000	37044284	0,65	6,37	364,07284	23,8508661
1700000	36979810	0,65	6,37	363,4281	23,8297379
1800000	37122652	0,65	6,37	364,85652	23,8765222
1900000	37176112	0,65	6,37	365,39112	23,8940081
2000000	37128727	0,65	6,37	364,91727	23,8785099
2100000	27557597	0,65	6,37	269,20597	20,5093717
2200000	10141559	0,65	6,37	95,04559	12,186416
2300000	1793105	0,65	6,37	11,56105	4,25019301
2400000	-359162	0,65	6,37	-2,77838	2,08355915
2500000	-50210	0,65	6,37	0,5021	0,88573769
2600000	-63518	0,65	6,37	0,63518	0,99622726

DISTANCE 2 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-48466	0,75	7,35	-6,86534	3,27522423
100000	-632494	0,75	7,35	-1,02506	1,26556559
200000	1348748	0,75	7,35	6,13748	3,09674224
300000	8863018	0,75	7,35	81,28018	11,2694401
400000	20161172	0,75	7,35	194,26172	17,4222254
500000	33301406	0,75	7,35	325,66406	22,5577059
600000	37154972	0,75	7,35	364,19972	23,8550217
700000	36976155	0,75	7,35	362,41155	23,7963873
800000	37052651	0,75	7,35	363,17651	23,8214881
900000	36925459	0,75	7,35	361,90459	23,7797376
1000000	37394597	0,75	7,35	366,59597	23,9333701
1100000	37028328	0,75	7,35	362,93328	23,8135098
1200000	36844455	0,75	7,35	361,09455	23,75311
1300000	37087798	0,75	7,35	363,52798	23,8330122
1400000	36942179	0,75	7,35	362,07179	23,7852301
1500000	37063679	0,75	7,35	363,28679	23,8251046
1600000	37119647	0,75	7,35	363,84647	23,84345
1700000	37202268	0,75	7,35	364,67268	23,8705061
1800000	37081838	0,75	7,35	363,46838	23,8310584
1900000	37373458	0,75	7,35	366,38458	23,9264687
2000000	36045176	0,75	7,35	353,10176	23,4887526
2100000	27656175	0,75	7,35	269,21175	20,5095919
2200000	13645285	0,75	7,35	129,10285	14,2029294
2300000	2575320	0,75	7,35	18,4032	5,36236888
2400000	4459	0,75	7,35	-7,30541	3,37856525
2500000	-50032	0,75	7,35	0,50032	0,88416627
2600000	-41373	0,75	7,35	0,41373	0,80402309

DISTANCE 2,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-75183	0,8	7,84	-7,08817	3,32795217
100000	-363733	0,8	7,84	-4,20267	2,56255183
200000	4319523	0,8	7,84	35,35523	7,43253301
300000	11218094	0,8	7,84	104,34094	12,7684266
400000	21516311	0,8	7,84	207,32311	17,9983988
500000	32154055	0,8	7,84	313,70055	22,1394921
600000	36775243	0,8	7,84	359,91243	23,7141977
700000	37111624	0,8	7,84	363,27624	23,8247587
800000	37204433	0,8	7,84	364,20433	23,8551727
900000	37221714	0,8	7,84	364,37714	23,8608315
1000000	37188451	0,8	7,84	364,04451	23,8499381
1100000	36758179	0,8	7,84	359,74179	23,7085754
1200000	36851319	0,8	7,84	360,67319	23,7392472
1300000	37351695	0,8	7,84	365,67695	23,9033519
1400000	36903479	0,8	7,84	361,19479	23,7564067
1500000	37105843	0,8	7,84	363,21843	23,8228629
1600000	36962236	0,8	7,84	361,78236	23,7757216
1700000	37147332	0,8	7,84	363,63332	23,836465
1800000	37247539	0,8	7,84	364,63539	23,8692856
1900000	36862716	0,8	7,84	360,78716	23,7429977
2000000	33773651	0,8	7,84	329,89651	22,7038168
2100000	24944903	0,8	7,84	241,60903	19,4297223
2200000	14026377	0,8	7,84	132,42377	14,3844409
2300000	4151759	0,8	7,84	33,67759	7,25404952
2400000	130212	0,8	7,84	-6,53788	3,19615981
2500000	-66167	0,8	7,84	0,66167	1,01678876
2600000	-22526	0,8	7,84	0,22526	0,59326954

DISTANCE 2,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-46326	0,9	8,82	-8,35674	3,61350332
100000	866290	0,9	8,82	-0,1571	0,49544803
200000	5624603	0,9	8,82	47,42603	8,60831992
300000	12174784	0,9	8,82	112,92784	13,2834389
400000	22427297	0,9	8,82	215,45297	18,3478954
500000	31090064	0,9	8,82	302,08064	21,725584
600000	36423135	0,9	8,82	355,41135	23,5654458
700000	37076452	0,9	8,82	361,94452	23,7810494
800000	36812186	0,9	8,82	359,30186	23,6940743
900000	36887790	0,9	8,82	360,0579	23,7189896
1000000	36897520	0,9	8,82	360,1552	23,7221942
1100000	36943249	0,9	8,82	360,61249	23,7372495
1200000	37131426	0,9	8,82	362,49426	23,7991025
1300000	36885600	0,9	8,82	360,036	23,7182683
1400000	36815064	0,9	8,82	359,33064	23,6950232
1500000	37207680	0,9	8,82	363,2568	23,8241212
1600000	37082360	0,9	8,82	362,0036	23,7829902
1700000	37233468	0,9	8,82	363,51468	23,8325762
1800000	37002770	0,9	8,82	361,2077	23,7568313
1900000	35823914	0,9	8,82	349,41914	23,3659454
2000000	31170877	0,9	8,82	302,88877	21,7546249
2100000	23335966	0,9	8,82	224,53966	18,7308093
2200000	13520741	0,9	8,82	126,38741	14,0527694
2300000	5029572	0,9	8,82	41,47572	8,05020574
2400000	539841	0,9	8,82	-3,42159	2,31219255
2500000	-15152	0,9	8,82	0,15152	0,48656963
2600000	-76367	0,9	8,82	0,76367	1,09235268

DISTANCE 2,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-76851	1,1	10,78	-10,01149	3,95511733
100000	2171764	1,1	10,78	10,93764	4,13401288
200000	7719386	1,1	10,78	66,41386	10,1868374
300000	13338791	1,1	10,78	122,60791	13,841057
400000	19911538	1,1	10,78	188,33538	17,1544173
500000	27762469	1,1	10,78	266,84469	20,4192269
600000	34343315	1,1	10,78	332,65315	22,7984769
700000	36930311	1,1	10,78	358,52311	23,6683831
800000	37039216	1,1	10,78	359,61216	23,7043034
900000	36943669	1,1	10,78	358,65669	23,6727919
1000000	36930998	1,1	10,78	358,52998	23,6686099
1100000	36888211	1,1	10,78	358,10211	23,6544826
1200000	37065933	1,1	10,78	359,87933	23,7131072
1300000	36909082	1,1	10,78	358,31082	23,6613748
1400000	37108160	1,1	10,78	360,3016	23,7270152
1500000	36825672	1,1	10,78	357,47672	23,6338185
1600000	37074363	1,1	10,78	359,96363	23,7158844
1700000	37302998	1,1	10,78	362,24998	23,7910822
1800000	37151738	1,1	10,78	360,73738	23,7413596
1900000	34995320	1,1	10,78	339,1732	23,0208194
2000000	31968361	1,1	10,78	308,90361	21,9695674
2100000	22864561	1,1	10,78	217,86561	18,4503392
2200000	14172479	1,1	10,78	130,94479	14,3038888
2300000	6983422	1,1	10,78	59,05422	9,60584295
2400000	1094237	1,1	10,78	0,16237	0,50368951
2500000	-95583	1,1	10,78	0,95583	1,22208198
2600000	-76634	1,1	10,78	0,76634	1,0942606

DISTANCE 3 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-183107	1,1	10,78	-8,94893	3,73934528
100000	2318427	1,1	10,78	12,40427	4,40246202
200000	8825388	1,1	10,78	77,47388	11,002406
300000	14285090	1,1	10,78	132,0709	14,365263
400000	18038984	1,1	10,78	169,60984	16,2792928
500000	27353629	1,1	10,78	262,75629	20,2621989
600000	33410056	1,1	10,78	323,32056	22,476396
700000	36551129	1,1	10,78	354,73129	23,5428894
800000	36627689	1,1	10,78	355,49689	23,5682815
900000	36715467	1,1	10,78	356,37467	23,5973605
1000000	36551779	1,1	10,78	354,73779	23,5431051
1100000	36695309	1,1	10,78	356,17309	23,5906857
1200000	36584404	1,1	10,78	355,06404	23,5539288
1300000	36860475	1,1	10,78	357,82475	23,6453203
1400000	36548582	1,1	10,78	354,70582	23,5420442
1500000	36638500	1,1	10,78	355,605	23,5718648
1600000	36805475	1,1	10,78	357,27475	23,6271411
1700000	36822170	1,1	10,78	357,4417	23,6326608
1800000	36432813	1,1	10,78	353,54813	23,5035945
1900000	34272982	1,1	10,78	331,94982	22,7743626
2000000	28889470	1,1	10,78	278,1147	20,8459641
2100000	22725895	1,1	10,78	216,47895	18,3915296
2200000	16329024	1,1	10,78	152,51024	15,4368795
2300000	9211128	1,1	10,78	81,33128	11,2729821
2400000	2853021	1,1	10,78	17,75021	5,26637476
2500000	-110024	1,1	10,78	1,10024	1,31115407
2600000	-94921	1,1	10,78	0,94921	1,21784261

DISTANCE 3,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-142752	1,1	10,78	-9,35248	3,82272808
100000	2795894	1,1	10,78	17,17894	5,18093561
200000	8654720	1,1	10,78	75,7672	10,8805446
300000	14169270	1,1	10,78	130,9127	14,302136
400000	19524244	1,1	10,78	184,46244	16,9771188
500000	25621957	1,1	10,78	245,43957	19,5831389
600000	32994950	1,1	10,78	319,1695	22,3316444
700000	36415622	1,1	10,78	353,37622	23,4978796
800000	36827098	1,1	10,78	357,49098	23,6342898
900000	36729246	1,1	10,78	356,51246	23,6019219
1000000	36691832	1,1	10,78	356,13832	23,5895342
1100000	36845741	1,1	10,78	357,67741	23,6404516
1200000	36653616	1,1	10,78	355,75616	23,5768743
1300000	36668808	1,1	10,78	355,90808	23,5819078
1400000	36770799	1,1	10,78	356,92799	23,6156724
1500000	36693793	1,1	10,78	356,15793	23,5901837
1600000	36743076	1,1	10,78	356,65076	23,6064994
1700000	36923880	1,1	10,78	358,4588	23,6662603
1800000	36521050	1,1	10,78	354,4305	23,5329058
1900000	32243387	1,1	10,78	311,65387	22,0671514
2000000	27833120	1,1	10,78	267,5512	20,4462405
2100000	22734975	1,1	10,78	216,56975	18,3953862
2200000	17217763	1,1	10,78	161,39763	15,8802959
2300000	9496864	1,1	10,78	84,18864	11,469296
2400000	3476297	1,1	10,78	23,98297	6,12155133
2500000	-11154	1,1	10,78	0,11154	0,41747006
2600000	22758	1,1	10,78	0,22758	0,59631682

DISTANCE 3,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-147948	1	9,8	-8,32052	3,60566395
100000	3667059	1	9,8	26,87059	6,47960623
200000	9560205	1	9,8	85,80205	11,5786745
300000	13705646	1	9,8	127,25646	14,1010006
400000	18775508	1	9,8	177,95508	16,6749756
500000	24129705	1	9,8	231,49705	19,0187839
600000	30149839	1	9,8	291,69839	21,348975
700000	35408363	1	9,8	344,28363	23,193602
800000	37127784	1	9,8	361,47784	23,7657132
900000	36741764	1	9,8	357,61764	23,6384763
1000000	36757122	1	9,8	357,77122	23,6435516
1100000	36791008	1	9,8	358,11008	23,6547458
1200000	36668159	1	9,8	356,88159	23,6141374
1300000	36943555	1	9,8	359,63555	23,7050743
1400000	36752678	1	9,8	357,72678	23,6420831
1500000	36842074	1	9,8	358,62074	23,6716055
1600000	36732723	1	9,8	357,52723	23,6354881
1700000	36908764	1	9,8	359,28764	23,6936054
1800000	35614317	1	9,8	346,34317	23,2628718
1900000	33216632	1	9,8	322,36632	22,4432033
2000000	28046512	1	9,8	270,66512	20,564879
2100000	22535757	1	9,8	215,55757	18,3523487
2200000	16084089	1	9,8	151,04089	15,3623368
2300000	11631238	1	9,8	106,51238	12,9006044
2400000	6261021	1	9,8	52,81021	9,08382921
2500000	-119219	1	9,8	1,19219	1,36484317
2600000	-71311	1	9,8	0,71311	1,05557301

DISTANCE 3,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-82543	1	9,8	-8,97457	3,74469834
100000	2388378	1	9,8	14,08378	4,69104533
200000	7532800	1	9,8	65,528	10,1186709
300000	14491554	1	9,8	135,11554	14,5299013
400000	19344930	1	9,8	183,6493	16,9396585
500000	23399039	1	9,8	224,19039	18,7162358
600000	30827173	1	9,8	298,47173	21,595418
700000	35011531	1	9,8	340,31531	23,0595462
800000	36610395	1	9,8	356,30395	23,595019
900000	36453481	1	9,8	354,73481	23,5430062
1000000	36496180	1	9,8	355,1618	23,5571711
1100000	36986648	1	9,8	360,06648	23,7192722
1200000	37123888	1	9,8	361,43888	23,7644325
1300000	36927407	1	9,8	359,47407	23,6997518
1400000	36683084	1	9,8	357,03084	23,6190747
1500000	36533543	1	9,8	355,53543	23,569559
1600000	36584595	1	9,8	356,04595	23,5864749
1700000	36476671	1	9,8	354,96671	23,5507003
1800000	35455251	1	9,8	344,75251	23,2093903
1900000	31521877	1	9,8	305,41877	21,845293
2000000	26491772	1	9,8	255,11772	19,9655062
2100000	21720559	1	9,8	207,40559	18,0019786
2200000	15633174	1	9,8	146,53174	15,1312869
2300000	12207435	1	9,8	112,27435	13,2449489
2400000	8000830	1	9,8	70,2083	10,4737992
2500000	-127763	1	9,8	1,27763	1,4129037
2600000	-127394	1	9,8	1,27394	1,41086188

DISTANCE 4 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-101365	1,05	10,29	-9,27635	3,80713762
100000	3595160	1,05	10,29	25,6616	6,33215998
200000	8783886	1,05	10,29	77,54886	11,0077288
300000	13531617	1,05	10,29	125,02617	13,9768877
400000	17437471	1,05	10,29	164,08471	16,0119443
500000	23208901	1,05	10,29	221,79901	18,6161476
600000	29534471	1,05	10,29	285,05471	21,1044541
700000	33906497	1,05	10,29	328,77497	22,6651912
800000	36494741	1,05	10,29	354,65741	23,5404376
900000	36647440	1,05	10,29	356,1844	23,5910603
1000000	36704720	1,05	10,29	356,7572	23,6100217
1100000	36831848	1,05	10,29	358,02848	23,6520507
1200000	36872331	1,05	10,29	358,43331	23,6654188
1300000	36802979	1,05	10,29	357,73979	23,642513
1400000	36956849	1,05	10,29	359,27849	23,6933037
1500000	36851561	1,05	10,29	358,22561	23,6585611
1600000	36884989	1,05	10,29	358,55989	23,6695971
1700000	36397615	1,05	10,29	353,68615	23,5081818
1800000	33063678	1,05	10,29	320,34678	22,3727925
1900000	29511231	1,05	10,29	284,82231	21,0958493
2000000	25805308	1,05	10,29	247,76308	19,6756147
2100000	18394467	1,05	10,29	173,65467	16,4722622
2200000	16524982	1,05	10,29	154,95982	15,5603573
2300000	12159388	1,05	10,29	111,30388	13,1875818
2400000	8287789	1,05	10,29	72,58789	10,6498159
2500000	-28154	1,05	10,29	0,28154	0,66325429
2600000	-71859	1,05	10,29	0,71859	1,0596211

DISTANCE 4,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-169392	0,95	9,31	-7,61608	3,44965578
100000	3154178	0,95	9,31	22,23178	5,89382357
200000	8129691	0,95	9,31	71,98691	10,6056375
300000	13612162	0,95	9,31	126,81162	14,0763332
400000	19142630	0,95	9,31	182,1163	16,868809
500000	22822117	0,95	9,31	218,91117	18,4945587
600000	27324492	0,95	9,31	263,93492	20,3075925
700000	33990672	0,95	9,31	330,59672	22,7278986
800000	36252760	0,95	9,31	353,2176	23,4926052
900000	37344436	0,95	9,31	364,13436	23,8528811
1000000	37482197	0,95	9,31	365,51197	23,8979592
1100000	37199174	0,95	9,31	362,68174	23,8052561
1200000	37084614	0,95	9,31	361,53614	23,7676296
1300000	37354738	0,95	9,31	364,23738	23,8562551
1400000	37204446	0,95	9,31	362,73446	23,8069862
1500000	37087569	0,95	9,31	361,56569	23,7686009
1600000	37044832	0,95	9,31	361,13832	23,7545496
1700000	36346435	0,95	9,31	354,15435	23,5237364
1800000	32290568	0,95	9,31	313,59568	22,1357912
1900000	30138404	0,95	9,31	292,07404	21,3627172
2000000	24862040	0,95	9,31	239,3104	19,3370758
2100000	17203806	0,95	9,31	162,72806	15,9456136
2200000	15881955	0,95	9,31	149,50955	15,2842622
2300000	12061256	0,95	9,31	111,30256	13,1875036
2400000	7625469	0,95	9,31	66,94469	10,2274668
2500000	-193550	0,95	9,31	1,9355	1,73902811
2600000	-183986	0,95	9,31	1,83986	1,69551799

DISTANCE 4,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-156696	0,8	7,84	-6,27304	3,1307547
100000	5010190	0,8	7,84	42,2619	8,12614415
200000	9827731	0,8	7,84	90,43731	11,8873166
300000	13110437	0,8	7,84	123,26437	13,878061
400000	17405177	0,8	7,84	166,21177	16,115393
500000	22386432	0,8	7,84	216,02432	18,3722073
600000	28391667	0,8	7,84	276,07667	20,7694438
700000	33277363	0,8	7,84	324,93363	22,5323944
800000	36115788	0,8	7,84	353,31788	23,4959398
900000	36868230	0,8	7,84	360,8423	23,7448119
1000000	37538942	0,8	7,84	367,54942	23,9644731
1100000	37166166	0,8	7,84	363,82166	23,8426371
1200000	37165962	0,8	7,84	363,81962	23,8425703
1300000	37114095	0,8	7,84	363,30095	23,8255689
1400000	37322061	0,8	7,84	365,38061	23,8936645
1500000	37279401	0,8	7,84	364,95401	23,8797119
1600000	36657780	0,8	7,84	358,7378	23,6754686
1700000	36031550	0,8	7,84	352,4755	23,4679136
1800000	31994492	0,8	7,84	312,10492	22,0831143
1900000	27167362	0,8	7,84	263,83362	20,303695
2000000	25220184	0,8	7,84	244,36184	19,5400966
2100000	19482832	0,8	7,84	186,98832	17,0929591
2200000	15266014	0,8	7,84	144,82014	15,042655
2300000	11214401	0,8	7,84	104,30401	12,7661668
2400000	6559670	0,8	7,84	57,7567	9,49972861
2500000	-126694	0,8	7,84	1,26694	1,40698037
2600000	-141173	0,8	7,84	1,41173	1,48520306

DISTANCE 4,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-111451	0,65	6,37	-5,25549	2,86560694
100000	2809367	0,65	6,37	21,72367	5,82608225
200000	6981308	0,65	6,37	63,44308	9,95639556
300000	11765765	0,65	6,37	111,28765	13,1866202
400000	15104757	0,65	6,37	144,67757	15,0352487
500000	21194371	0,65	6,37	205,57371	17,9223024
600000	23695307	0,65	6,37	230,58307	18,9812025
700000	31281909	0,65	6,37	306,44909	21,8821092
800000	33589103	0,65	6,37	329,52103	22,6908927
900000	37076923	0,65	6,37	364,39923	23,8615548
1000000	37232818	0,65	6,37	365,95818	23,9125418
1100000	37219040	0,65	6,37	365,8204	23,90804
1200000	37073370	0,65	6,37	364,3637	23,8603915
1300000	37162868	0,65	6,37	365,25868	23,8896774
1400000	37220377	0,65	6,37	365,83377	23,9084769
1500000	37157659	0,65	6,37	365,20659	23,8879739
1600000	37199543	0,65	6,37	365,62543	23,901668
1700000	36167860	0,65	6,37	355,3086	23,5620391
1800000	32312268	0,65	6,37	316,75268	22,2469338
1900000	28295331	0,65	6,37	276,58331	20,7884925
2000000	25067077	0,65	6,37	244,30077	19,5376547
2100000	19846197	0,65	6,37	192,09197	17,3246559
2200000	15727601	0,65	6,37	150,90601	15,3554759
2300000	9706117	0,65	6,37	90,69117	11,903989
2400000	8192828	0,65	6,37	75,55828	10,8655332
2500000	-110839	0,65	6,37	1,10839	1,31600128
2600000	-112558	0,65	6,37	1,12558	1,32616694

DISTANCE 5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-114762	0,6	5,88	-4,73238	2,71925426
100000	3631963	0,6	5,88	30,43963	6,8965152
200000	7137840	0,6	5,88	65,4984	10,1163852
300000	13139306	0,6	5,88	125,51306	14,0040764
400000	15219177	0,6	5,88	146,31177	15,1199253
500000	20833565	0,6	5,88	202,45565	17,7858639
600000	24887916	0,6	5,88	242,99916	19,4855379
700000	31309581	0,6	5,88	307,21581	21,9094661
800000	34525405	0,6	5,88	339,37405	23,0276346
900000	36989055	0,6	5,88	364,01055	23,8488256
1000000	37249258	0,6	5,88	366,61258	23,9339123
1100000	37422918	0,6	5,88	368,34918	23,9905313
1200000	37243719	0,6	5,88	366,55719	23,9321042
1300000	37091822	0,6	5,88	365,03822	23,8824668
1400000	37046933	0,6	5,88	364,58933	23,867778
1500000	37383875	0,6	5,88	367,95875	23,9778136
1600000	37104353	0,6	5,88	365,16353	23,8865656
1700000	35723617	0,6	5,88	351,35617	23,4306213
1800000	31693271	0,6	5,88	311,05271	22,0458581
1900000	27386662	0,6	5,88	267,98662	20,4628711
2000000	21051426	0,6	5,88	204,63426	17,881304
2100000	19508084	0,6	5,88	189,20084	17,193787
2200000	14843841	0,6	5,88	142,55841	14,9247283
2300000	11196369	0,6	5,88	106,08369	12,8746171
2400000	8262868	0,6	5,88	76,74868	10,9507905
2500000	-112355	0,6	5,88	1,12355	1,32497052
2600000	-99849	0,6	5,88	0,99849	1,24905589

DISTANCE 5,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-129317	0,55	5,39	-4,09683	2,53007843
100000	2947829	0,55	5,39	24,08829	6,13497784
200000	7094021	0,55	5,39	65,55021	10,1203855
300000	10106934	0,55	5,39	95,67934	12,2269771
400000	16032973	0,55	5,39	154,93973	15,5593486
500000	20719935	0,55	5,39	201,80935	17,7574522
600000	25107497	0,55	5,39	245,68497	19,5929264
700000	31060240	0,55	5,39	305,2124	21,8379114
800000	33959944	0,55	5,39	334,20944	22,851745
900000	36578916	0,55	5,39	360,39916	23,7302273
1000000	37374311	0,55	5,39	368,35311	23,9906593
1100000	37044781	0,55	5,39	365,05781	23,8831076
1200000	37223815	0,55	5,39	366,84815	23,9416005
1300000	37178315	0,55	5,39	366,39315	23,9267486
1400000	37482923	0,55	5,39	369,43923	24,0260025
1500000	37110020	0,55	5,39	365,7102	23,9044387
1600000	36900678	0,55	5,39	363,61678	23,8359229
1700000	33802800	0,55	5,39	332,638	22,7979577
1800000	28378805	0,55	5,39	278,39805	20,8565806
1900000	23975898	0,55	5,39	234,36898	19,1363928
2000000	23344319	0,55	5,39	228,05319	18,8767876
2100000	18502455	0,55	5,39	179,63455	16,7534768
2200000	13620223	0,55	5,39	130,81223	14,2966468
2300000	12470173	0,55	5,39	119,31173	13,6537386
2400000	7204938	0,55	5,39	66,65938	10,2056495
2500000	-134806	0,55	5,39	1,34806	1,45132483
2600000	-146203	0,55	5,39	1,46203	1,51143041

DISTANCE 5,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-154582	0,65	6,37	-4,82418	2,745502
100000	2860216	0,65	6,37	22,23216	5,89387394
200000	6917852	0,65	6,37	62,80852	9,90647831
300000	9577753	0,65	6,37	89,40753	11,8194444
400000	14873970	0,65	6,37	142,3697	14,9148468
500000	18896053	0,65	6,37	182,59053	16,8907579
600000	25170125	0,65	6,37	245,33125	19,5788171
700000	28486309	0,65	6,37	278,49309	20,8601403
800000	33998236	0,65	6,37	333,61236	22,8313231
900000	36668146	0,65	6,37	360,31146	23,7273398
1000000	37009952	0,65	6,37	363,72952	23,8396178
1100000	37513244	0,65	6,37	368,76244	24,0039853
1200000	37385683	0,65	6,37	367,48683	23,9624325
1300000	37103780	0,65	6,37	364,6678	23,8703464
1400000	37147332	0,65	6,37	365,10332	23,8845962
1500000	36884390	0,65	6,37	362,4739	23,7984342
1600000	35807538	0,65	6,37	351,70538	23,4422622
1700000	34796802	0,65	6,37	341,59802	23,1029631
1800000	30321742	0,65	6,37	296,84742	21,5365757
1900000	26775382	0,65	6,37	261,38382	20,2092112
2000000	22654162	0,65	6,37	220,17162	18,5477264
2100000	19187405	0,65	6,37	185,50405	17,0249839
2200000	13869055	0,65	6,37	132,32055	14,3788337
2300000	10444232	0,65	6,37	98,07232	12,3789337
2400000	5307387	0,65	6,37	46,70387	8,54252872
2500000	-122873	0,65	6,37	1,22873	1,38560118
2600000	-148661	0,65	6,37	1,48661	1,52408272

DISTANCE 5,75 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-145401	0,8	7,84	-6,38599	3,15881455
100000	1786330	0,8	7,84	10,0233	3,95744946
200000	4783198	0,8	7,84	39,99198	7,90490156
300000	8506300	0,8	7,84	77,223	10,9845773
400000	15094710	0,8	7,84	143,1071	14,9534225
500000	16266906	0,8	7,84	154,82906	15,5537907
600000	22743278	0,8	7,84	219,59278	18,523329
700000	27140034	0,8	7,84	263,56034	20,293177
800000	33159314	0,8	7,84	323,75314	22,4914268
900000	35317018	0,8	7,84	345,33018	23,2288271
1000000	36417786	0,8	7,84	356,33786	23,5961418
1100000	37414921	0,8	7,84	366,30921	23,9240076
1200000	37242598	0,8	7,84	364,58598	23,8676684
1300000	37123022	0,8	7,84	363,39022	23,8284959
1400000	36974881	0,8	7,84	361,90881	23,7798763
1500000	37251436	0,8	7,84	364,67436	23,8705611
1600000	36975263	0,8	7,84	361,91263	23,7800018
1700000	34295981	0,8	7,84	335,11981	22,8828474
1800000	31116615	0,8	7,84	303,32615	21,7703263
1900000	28230614	0,8	7,84	274,46614	20,7087746
2000000	21704577	0,8	7,84	209,20577	18,0799341
2100000	16438515	0,8	7,84	156,54515	15,6397505
2200000	12704805	0,8	7,84	119,20805	13,6478049
2300000	9315831	0,8	7,84	85,31831	11,5459889
2400000	6033825	0,8	7,84	52,49825	9,05695951
2500000	-163382	0,8	7,84	1,63382	1,59776211
2600000	-141746	0,8	7,84	1,41746	1,48821411

DISTANCE 6 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-135366	1,3	12,74	-11,38634	4,21795641
100000	2484994	1,3	12,74	12,10994	4,34991738
200000	5817008	1,3	12,74	45,43008	8,42522997
300000	8271553	1,3	12,74	69,97553	10,4564222
400000	16900968	1,3	12,74	156,26968	15,625984
500000	19127756	1,3	12,74	178,53756	16,7022435
600000	25247168	1,3	12,74	239,73168	19,3540887
700000	29503183	1,3	12,74	282,29183	21,0019281
800000	32833948	1,3	12,74	315,59948	22,2063997
900000	34958530	1,3	12,74	336,8453	22,9416822
1000000	36778478	1,3	12,74	355,04478	23,55329
1100000	37066646	1,3	12,74	357,92646	23,6486806
1200000	37342793	1,3	12,74	360,68793	23,7397323
1300000	37242878	1,3	12,74	359,68878	23,7068285
1400000	36753314	1,3	12,74	354,79314	23,5449417
1500000	36600259	1,3	12,74	353,26259	23,4941013
1600000	36349772	1,3	12,74	350,75772	23,4106586
1700000	32998542	1,3	12,74	317,24542	22,2642307
1800000	30322697	1,3	12,74	290,48697	21,3045979
1900000	26145522	1,3	12,74	248,71522	19,7133846
2000000	20695982	1,3	12,74	194,21982	17,4203464
2100000	16917090	1,3	12,74	156,4309	15,6340424
2200000	13583930	1,3	12,74	123,0993	13,8687655
2300000	8720010	1,3	12,74	74,4601	10,7862832
2400000	5256691	1,3	12,74	39,82691	7,88857065
2500000	-135111	1,3	12,74	1,35111	1,45296572
2600000	-168106	1,3	12,74	1,68106	1,62069622

DISTANCE 6,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-130145	1,5	14,7	-13,39855	4,57550373
100000	2632218	1,5	14,7	11,62218	4,26141482
200000	6260843	1,5	14,7	47,90843	8,65198947
300000	6447161	1,5	14,7	49,77161	8,81862464
400000	12867972	1,5	14,7	113,97972	13,3451606
500000	18961571	1,5	14,7	174,91571	16,5319629
600000	21946010	1,5	14,7	204,7601	17,8868012
700000	26795044	1,5	14,7	253,25044	19,8923054
800000	30077699	1,5	14,7	286,07699	21,1422633
900000	35039216	1,5	14,7	335,69216	22,9023798
1000000	36751672	1,5	14,7	352,81672	23,4792701
1100000	37062405	1,5	14,7	355,92405	23,5824369
1200000	37140430	1,5	14,7	356,7043	23,6082712
1300000	36967903	1,5	14,7	354,97903	23,551109
1400000	36641022	1,5	14,7	351,71022	23,4424235
1500000	36859825	1,5	14,7	353,89825	23,5152294
1600000	35871401	1,5	14,7	344,01401	23,1845183
1700000	33902027	1,5	14,7	324,32027	22,5111177
1800000	29509155	1,5	14,7	280,39155	20,9311203
1900000	25284722	1,5	14,7	238,14722	19,2900241
2000000	20503602	1,5	14,7	190,33602	17,2452901
2100000	13519786	1,5	14,7	120,49786	13,7214397
2200000	13921343	1,5	14,7	124,51343	13,9481982
2300000	10276074	1,5	14,7	88,06074	11,7300855
2400000	6778384	1,5	14,7	53,08384	9,10733221
2500000	-129062	1,5	14,7	1,29062	1,42006822
2600000	-171774	1,5	14,7	1,71774	1,63828226

1.4. Tables of measures at 45 m/s:

DISTANCE 0 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-182624	3,15	30,87	-29,04376	6,73653286
100000	-682808	3,15	30,87	-24,04192	6,12907008
200000	-2199459	3,15	30,87	-8,87541	3,72395329
300000	-1814623	3,15	30,87	-12,72377	4,45879924
400000	114578162	3,15	30,87	1114,91162	41,7378654
500000	115763614	3,15	30,87	1126,76614	41,9591717
600000	114230053	3,15	30,87	1111,43053	41,6726553
700000	116016712	3,15	30,87	1129,29712	42,0062704
800000	115079684	3,15	30,87	1119,92684	41,831635
900000	114512758	3,15	30,87	1114,25758	41,7256213
1000000	114386814	3,15	30,87	1112,99814	41,7020334
1100000	115130418	3,15	30,87	1120,43418	41,841109
1200000	115085071	3,15	30,87	1119,98071	41,8326411
1300000	113633812	3,15	30,87	1105,46812	41,5607259
1400000	114717070	3,15	30,87	1116,3007	41,7638581
1500000	115475522	3,15	30,87	1123,88522	41,9054967
1600000	114403280	3,15	30,87	1113,1628	41,7051181
1700000	114645731	3,15	30,87	1115,58731	41,750511
1800000	114829579	3,15	30,87	1117,42579	41,7848991
1900000	114117060	3,15	30,87	1110,3006	41,6514668
2000000	114115188	3,15	30,87	1110,28188	41,6511157
2100000	114188907	3,15	30,87	1111,01907	41,6649409
2200000	-2345014	3,15	30,87	-7,41986	3,4049275
2300000	-1207138	3,15	30,87	-18,79862	5,41967192
2400000	232215	3,15	30,87	-28,54785	6,67877351
2500000	-79041	3,15	30,87	0,79041	1,11131257
2600000	-37591	3,15	30,87	0,37591	0,76639375

DISTANCE 0,25 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-88949	3	29,4	-28,51051	6,67440423
100000	-1421841	3	29,4	-15,18159	4,87044499
200000	-1032917	3	29,4	-19,07083	5,45877018
300000	-1762093	3	29,4	-11,77907	4,29008122
400000	115370832	3	29,4	1124,30832	41,9133839
500000	114854908	3	29,4	1119,14908	41,817107
600000	115318303	3	29,4	1123,78303	41,9035915
700000	114858461	3	29,4	1119,18461	41,8177708
800000	114555966	3	29,4	1116,15966	41,7612197
900000	114835348	3	29,4	1118,95348	41,8134525
1000000	114657243	3	29,4	1117,17243	41,7801618
1100000	113903375	3	29,4	1109,63375	41,6389569
1200000	114311579	3	29,4	1113,71579	41,7154758
1300000	113475688	3	29,4	1105,35688	41,5586348
1400000	115642484	3	29,4	1127,02484	41,9639883
1500000	116017833	3	29,4	1130,77833	42,0338095
1600000	113597353	3	29,4	1106,57353	41,5815
1700000	115344688	3	29,4	1124,04688	41,9085105
1800000	113795247	3	29,4	1108,55247	41,6186645
1900000	113854997	3	29,4	1109,14997	41,629879
2000000	114692225	3	29,4	1117,52225	41,7867026
2100000	115397142	3	29,4	1124,57142	41,9182877
2200000	-193231	3	29,4	-27,46769	6,55120337
2300000	-389482	3	29,4	-25,50518	6,31283167
2400000	-338519	3	29,4	-26,01481	6,37558943
2500000	44139	3	29,4	0,44139	0,83046485
2600000	-60207	3	29,4	0,60207	0,96991462

DISTANCE 0,5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-87879	2,8	27,44	-26,56121	6,4421961
100000	-1240871	2,8	27,44	-15,03129	4,84627595
200000	-1276146	2,8	27,44	-14,67854	4,78907285
300000	279931	2,8	27,44	-24,64069	6,2049237
400000	116088025	2,8	27,44	1133,44025	42,0832555
500000	116132800	2,8	27,44	1133,888	42,0915669
600000	115686074	2,8	27,44	1129,42074	42,0085694
700000	115343542	2,8	27,44	1125,99542	41,944819
800000	114214478	2,8	27,44	1114,70478	41,7339936
900000	115460674	2,8	27,44	1127,16674	41,96663
1000000	114339072	2,8	27,44	1115,95072	41,7573107
1100000	115281436	2,8	27,44	1125,37436	41,9332498
1200000	114944049	2,8	27,44	1122,00049	41,8703447
1300000	115978802	2,8	27,44	1132,34802	42,062974
1400000	114420942	2,8	27,44	1116,76942	41,7726252
1500000	114354621	2,8	27,44	1116,10621	41,7602197
1600000	115204418	2,8	27,44	1124,60418	41,9188983
1700000	115452384	2,8	27,44	1127,08384	41,9650867
1800000	115110005	2,8	27,44	1123,66005	41,9012986
1900000	115386419	2,8	27,44	1126,42419	41,9528044
2000000	114848668	2,8	27,44	1121,04668	41,852544
2100000	115691958	2,8	27,44	1129,47958	42,0096637
2200000	3804057	2,8	27,44	10,60057	4,06981457
2300000	-324613	2,8	27,44	-24,19387	6,14840808
2400000	-289771	2,8	27,44	-24,54229	6,19252195
2500000	-96653	2,8	27,44	0,96653	1,22890322
2600000	-54311	2,8	27,44	0,54311	0,92119996

DISTANCE 1 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-112788	2,15	21,07	-19,94212	5,58207511
100000	-1335616	2,15	21,07	-7,71384	3,47172508
200000	-1842919	2,15	21,07	-2,64081	2,03132115
300000	15726467	2,15	21,07	136,19467	14,587809
400000	104208976	2,15	21,07	1021,01976	39,9417498
500000	114320251	2,15	21,07	1122,13251	41,872808
600000	115012586	2,15	21,07	1129,05586	42,0017831
700000	114357945	2,15	21,07	1122,50945	41,8798402
800000	114840378	2,15	21,07	1127,33378	41,9697395
900000	114785186	2,15	21,07	1126,78186	41,9594644
1000000	114698363	2,15	21,07	1125,91363	41,9432956
1100000	115375302	2,15	21,07	1132,68302	42,0691956
1200000	114840390	2,15	21,07	1127,3339	41,9697417
1300000	114555278	2,15	21,07	1124,48278	41,9166356
1400000	115353628	2,15	21,07	1132,46628	42,0651704
1500000	113636830	2,15	21,07	1115,2983	41,7451026
1600000	114460610	2,15	21,07	1123,5361	41,8989875
1700000	114671506	2,15	21,07	1125,64506	41,9382928
1800000	114522525	2,15	21,07	1124,15525	41,9105306
1900000	114590387	2,15	21,07	1124,83387	41,9231788
2000000	115269415	2,15	21,07	1131,62415	42,0495272
2100000	101795742	2,15	21,07	996,88742	39,466905
2200000	14664297	2,15	21,07	125,57297	14,0074182
2300000	-492975	2,15	21,07	-16,14025	5,02186625
2400000	-375411	2,15	21,07	-17,31589	5,20154574
2500000	-73222	2,15	21,07	0,73222	1,06962318
2600000	-55075	2,15	21,07	0,55075	0,92765666

DISTANCE 2 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-78952	2,4	23,52	-22,73048	5,95956164
100000	-1367948	2,4	23,52	-9,84052	3,92120039
200000	3480079	2,4	23,52	11,28079	4,19836092
300000	28083747	2,4	23,52	257,31747	20,0513976
400000	70709359	2,4	23,52	683,57359	32,6815504
500000	110417949	2,4	23,52	1080,65949	41,0917322
600000	115077888	2,4	23,52	1127,25888	41,9683452
700000	115165336	2,4	23,52	1128,13336	41,9846207
800000	115136824	2,4	23,52	1127,84824	41,9793148
900000	114948977	2,4	23,52	1125,96977	41,9443413
1000000	115588006	2,4	23,52	1132,36006	42,0631976
1100000	114202699	2,4	23,52	1118,50699	41,8051094
1200000	115392519	2,4	23,52	1130,40519	42,0268737
1300000	114395919	2,4	23,52	1120,43919	41,8412026
1400000	115264270	2,4	23,52	1129,1227	42,0030263
1500000	115463246	2,4	23,52	1131,11246	42,0400193
1600000	115929901	2,4	23,52	1135,77901	42,1266507
1700000	115308382	2,4	23,52	1129,56382	42,0112303
1800000	114531949	2,4	23,52	1121,79949	41,8665941
1900000	115578111	2,4	23,52	1132,26111	42,0613598
2000000	114907094	2,4	23,52	1125,55094	41,9365395
2100000	87849772	2,4	23,52	854,97772	36,5500026
2200000	34280228	2,4	23,52	319,28228	22,3355896
2300000	7786878	2,4	23,52	54,34878	9,21520313
2400000	-54005	2,4	23,52	-22,97995	5,99217589
2500000	-60169	2,4	23,52	0,60169	0,96960849
2600000	-26002	2,4	23,52	0,26002	0,63740195

DISTANCE 3 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-113437	2,5	24,5	-23,36563	6,04225098
100000	4102413	2,5	24,5	16,52413	5,08123539
200000	16946239	2,5	24,5	144,96239	15,050041
300000	40787214	2,5	24,5	383,37214	24,474864
400000	64567153	2,5	24,5	621,17153	31,1541412
500000	93945791	2,5	24,5	914,95791	37,810339
600000	110548643	2,5	24,5	1080,98643	41,0979476
700000	114627190	2,5	24,5	1121,7719	41,8660793
800000	114664999	2,5	24,5	1122,14999	41,8731341
900000	114734605	2,5	24,5	1122,84605	41,8861189
1000000	115645388	2,5	24,5	1131,95388	42,0556529
1100000	114583090	2,5	24,5	1121,3309	41,8578491
1200000	115043887	2,5	24,5	1125,93887	41,9437657
1300000	116307287	2,5	24,5	1138,57287	42,1784318
1400000	115434581	2,5	24,5	1129,84581	42,0164739
1500000	114473497	2,5	24,5	1120,23497	41,8373893
1600000	114905527	2,5	24,5	1124,55527	41,9179867
1700000	114684890	2,5	24,5	1122,3489	41,8768451
1800000	114355385	2,5	24,5	1119,05385	41,8153278
1900000	115260628	2,5	24,5	1128,10628	41,9841168
2000000	101150982	2,5	24,5	987,00982	39,2708905
2100000	75295095	2,5	24,5	728,45095	33,7372881
2200000	42623309	2,5	24,5	401,73309	25,0541005
2300000	19430901	2,5	24,5	169,80901	16,2888483
2400000	6845164	2,5	24,5	43,95164	8,28700413
2500000	-107719	2,5	24,5	1,07719	1,29734705
2600000	8878	2,5	24,5	0,08878	0,37244966

DISTANCE 4 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-39004	2,1	20,58	-20,18996	5,61665492
100000	9204875	2,1	20,58	71,46875	10,567399
200000	22209219	2,1	20,58	201,51219	17,7443737
300000	39593497	2,1	20,58	375,35497	24,2175998
400000	52913045	2,1	20,58	508,55045	28,188829
500000	77520495	2,1	20,58	754,62495	34,3380472
600000	98164149	2,1	20,58	961,06149	38,7512397
700000	106444678	2,1	20,58	1043,86678	40,3861591
800000	114270230	2,1	20,58	1122,1223	41,8726175
900000	114163388	2,1	20,58	1121,05388	41,8526784
1000000	113996324	2,1	20,58	1119,38324	41,8214815
1100000	114963265	2,1	20,58	1129,05265	42,0017234
1200000	115713988	2,1	20,58	1136,55988	42,1411297
1300000	114783544	2,1	20,58	1127,25544	41,9682812
1400000	114888667	2,1	20,58	1128,30667	41,9878455
1500000	115765614	2,1	20,58	1137,07614	42,1506995
1600000	116185775	2,1	20,58	1141,27775	42,2285032
1700000	114035546	2,1	20,58	1119,77546	41,8288077
1800000	114740030	2,1	20,58	1126,8203	41,9601802
1900000	105555799	2,1	20,58	1034,97799	40,2138423
2000000	95193973	2,1	20,58	931,35973	38,1477336
2100000	72082149	2,1	20,58	700,24149	33,0775956
2200000	46078159	2,1	20,58	440,20159	26,226227
2300000	30347631	2,1	20,58	282,89631	21,0244021
2400000	15995559	2,1	20,58	139,37559	14,7571799
2500000	-11650	2,1	20,58	0,1165	0,4266512
2600000	-38533	2,1	20,58	0,38533	0,77593693

DISTANCE 5 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-48338	2,5	24,5	-24,01662	6,12584433
100000	6749961	2,5	24,5	42,99961	8,19676098
200000	24466227	2,5	24,5	220,16227	18,5473326
300000	32033612	2,5	24,5	295,83612	21,499859
400000	44050793	2,5	24,5	416,00793	25,4953406
500000	69685559	2,5	24,5	672,35559	32,4122756
600000	87812537	2,5	24,5	853,62537	36,5210849
700000	98901705	2,5	24,5	964,51705	38,8208435
800000	107972179	2,5	24,5	1055,22179	40,6052219
900000	111598855	2,5	24,5	1091,48855	41,2971047
1000000	114974790	2,5	24,5	1125,2479	41,9308937
1100000	115139014	2,5	24,5	1126,89014	41,9614805
1200000	115034362	2,5	24,5	1125,84362	41,9419916
1300000	114853099	2,5	24,5	1124,03099	41,9082143
1400000	114948404	2,5	24,5	1124,98404	41,9259772
1500000	115440643	2,5	24,5	1129,90643	42,017601
1600000	115359257	2,5	24,5	1129,09257	42,0024659
1700000	113102045	2,5	24,5	1106,52045	41,5805027
1800000	110060442	2,5	24,5	1076,10442	41,0050382
1900000	96688644	2,5	24,5	942,38644	38,3728916
2000000	79088046	2,5	24,5	766,38046	34,6044718
2100000	63268364	2,5	24,5	608,18364	30,8267244
2200000	47276728	2,5	24,5	448,26728	26,4654043
2300000	31551765	2,5	24,5	291,01765	21,3240493
2400000	23831362	2,5	24,5	213,81362	18,2779589
2500000	-87344	2,5	24,5	0,87344	1,16822515
2600000	-56680	2,5	24,5	0,5668	0,94107651

DISTANCE 6 METERS

Points	Ptotal	h(mm)	Pest	Pdin	Vel
0	-115220	3,9	38,22	-37,0678	7,61041638
100000	7484435	3,9	38,22	36,62435	7,56475689
200000	18103523	3,9	38,22	142,81523	14,9381658
300000	32961166	3,9	38,22	291,39166	21,3377475
400000	45384130	3,9	38,22	415,6213	25,4834904
500000	61169404	3,9	38,22	573,47404	29,9341475
600000	76389025	3,9	38,22	725,67025	33,6728342
700000	89394770	3,9	38,22	855,7277	36,5660297
800000	105490828	3,9	38,22	1016,68828	39,8569371
900000	114740934	3,9	38,22	1109,18934	41,6306179
1000000	113295495	3,9	38,22	1094,73495	41,3584739
1100000	116445775	3,9	38,22	1126,23775	41,9493323
1200000	115101778	3,9	38,22	1112,79778	41,6982797
1300000	115925877	3,9	38,22	1121,03877	41,8523963
1400000	115733778	3,9	38,22	1119,11778	41,8165222
1500000	115756037	3,9	38,22	1119,34037	41,8206806
1600000	115068070	3,9	38,22	1112,4607	41,6919638
1700000	105416930	3,9	38,22	1015,9493	39,8424495
1800000	100181010	3,9	38,22	963,5901	38,8021846
1900000	96557313	3,9	38,22	927,35313	38,0655916
2000000	77218154	3,9	38,22	733,96154	33,8646557
2100000	60285593	3,9	38,22	564,63593	29,7025864
2200000	46751889	3,9	38,22	429,29889	25,8994115
2300000	33326684	3,9	38,22	295,04684	21,4711594
2400000	20856118	3,9	38,22	170,34118	16,3143524
2500000	-73158	3,9	38,22	0,73158	1,06915562
2600000	-113119	3,9	38,22	1,13119	1,3294677

1.5. Table of air properties at 1 atm:

Temp. T, °C	Density ρ, kg/m³	Specific Heat c_p J/kg·K	Thermal Conductivity k, W/m·K	Thermal Diffusivity α, m²/s	Dynamic Viscosity μ, kg/m·s	Kinematic Viscosity ν, m²/s	Prandtl Number Pr
−150	2.866	983	0.01171	4.158×10^{-6}	8.636×10^{-6}	3.013×10^{-6}	0.7246
−100	2.038	966	0.01582	8.036×10^{-6}	1.189×10^{-6}	5.837×10^{-6}	0.7263
−50	1.582	999	0.01979	1.252×10^{-5}	1.474×10^{-5}	9.319×10^{-6}	0.7440
−40	1.514	1002	0.02057	1.356×10^{-5}	1.527×10^{-5}	1.008×10^{-5}	0.7436
−30	1.451	1004	0.02134	1.465×10^{-5}	1.579×10^{-5}	1.087×10^{-5}	0.7425
−20	1.394	1005	0.02211	1.578×10^{-5}	1.630×10^{-5}	1.169×10^{-5}	0.7408
−10	1.341	1006	0.02288	1.696×10^{-5}	1.680×10^{-5}	1.252×10^{-5}	0.7387
0	1.292	1006	0.02364	1.818×10^{-5}	1.729×10^{-5}	1.338×10^{-5}	0.7362
5	1.269	1006	0.02401	1.880×10^{-5}	1.754×10^{-5}	1.382×10^{-5}	0.7350
10	1.246	1006	0.02439	1.944×10^{-5}	1.778×10^{-5}	1.426×10^{-5}	0.7336
15	1.225	1007	0.02476	2.009×10^{-5}	1.802×10^{-5}	1.470×10^{-5}	0.7323
20	1.204	1007	0.02514	2.074×10^{-5}	1.825×10^{-5}	1.516×10^{-5}	0.7309
25	1.184	1007	0.02551	2.141×10^{-5}	1.849×10^{-5}	1.562×10^{-5}	0.7296
30	1.164	1007	0.02588	2.208×10^{-5}	1.872×10^{-5}	1.608×10^{-5}	0.7282
35	1.145	1007	0.02625	2.277×10^{-5}	1.895×10^{-5}	1.655×10^{-5}	0.7268
40	1.127	1007	0.02662	2.346×10^{-5}	1.918×10^{-5}	1.702×10^{-5}	0.7255
45	1.109	1007	0.02699	2.416×10^{-5}	1.941×10^{-5}	1.750×10^{-5}	0.7241
50	1.092	1007	0.02735	2.487×10^{-5}	1.963×10^{-5}	1.798×10^{-5}	0.7228
60	1.059	1007	0.02808	2.632×10^{-5}	2.008×10^{-5}	1.896×10^{-5}	0.7202
70	1.028	1007	0.02881	2.780×10^{-5}	2.052×10^{-5}	1.995×10^{-5}	0.7177
80	0.9994	1008	0.02953	2.931×10^{-5}	2.096×10^{-5}	2.097×10^{-5}	0.7154
90	0.9718	1008	0.03024	3.086×10^{-5}	2.139×10^{-5}	2.201×10^{-5}	0.7132
100	0.9458	1009	0.03095	3.243×10^{-5}	2.181×10^{-5}	2.306×10^{-5}	0.7111
120	0.8977	1011	0.03235	3.565×10^{-5}	2.264×10^{-5}	2.522×10^{-5}	0.7073
140	0.8542	1013	0.03374	3.898×10^{-5}	2.345×10^{-5}	2.745×10^{-5}	0.7041
160	0.8148	1016	0.03511	4.241×10^{-5}	2.420×10^{-5}	2.975×10^{-5}	0.7014
180	0.7788	1019	0.03646	4.593×10^{-5}	2.504×10^{-5}	3.212×10^{-5}	0.6992
200	0.7459	1023	0.03779	4.954×10^{-5}	2.577×10^{-5}	3.455×10^{-5}	0.6974
250	0.6746	1033	0.04104	5.890×10^{-5}	2.760×10^{-5}	4.091×10^{-5}	0.6946
300	0.6158	1044	0.04418	6.871×10^{-5}	2.934×10^{-5}	4.765×10^{-5}	0.6935
350	0.5664	1056	0.04721	7.892×10^{-5}	3.101×10^{-5}	5.475×10^{-5}	0.6937
400	0.5243	1069	0.05015	8.951×10^{-5}	3.261×10^{-5}	6.219×10^{-5}	0.6948
450	0.4880	1081	0.05298	1.004×10^{-4}	3.415×10^{-5}	6.997×10^{-5}	0.6965
500	0.4565	1093	0.05572	1.117×10^{-4}	3.563×10^{-5}	7.806×10^{-5}	0.6986
600	0.4042	1115	0.06093	1.352×10^{-4}	3.846×10^{-5}	9.515×10^{-5}	0.7037
700	0.3627	1135	0.06581	1.598×10^{-4}	4.111×10^{-5}	1.133×10^{-4}	0.7092
800	0.3289	1153	0.07037	1.855×10^{-4}	4.362×10^{-5}	1.326×10^{-4}	0.7149
900	0.3008	1169	0.07465	2.122×10^{-4}	4.600×10^{-5}	1.529×10^{-4}	0.7206
1000	0.2772	1184	0.07868	2.398×10^{-4}	4.826×10^{-5}	1.741×10^{-4}	0.7260
1500	0.1990	1234	0.09599	3.908×10^{-4}	5.817×10^{-5}	2.922×10^{-4}	0.7478
2000	0.1553	1264	0.11113	5.664×10^{-4}	6.630×10^{-5}	4.270×10^{-4}	0.7539

APPENDIX 2. Matlab Code:

The codes of this appendix have references to two Excel documents named “Results and operations” and “Final results”.

2.1 Matlab code results of Measurements:

2.1.1 Measurements 10m/s code:

```
>> %Grafica 10m/s.
A=xlsread('Results and operations.ods', 'Hoja1','H2:J703');
X=A(:,2);
Y=A(:,3);
Z=A(:,1);
plot3(Z,X,Y)
```

2.1.2 Measurements 10m/s code:

```
>> %Grafica 25m/s.
A=xlsread('Results and operations.ods', 'Hoja2','H2:J703');
X=A(:,2);
Y=A(:,3);
Z=A(:,1);
plot3(Z,X,Y)
```

2.1.3 Measurements 10m/s code:

```
%Grafica 45m/s.
A=xlsread('Results and operations.ods', 'Hoja3','H2:J244');
X=A(:,2);
Y=A(:,3);
Z=A(:,1);
plot3(Z,X,Y)
```

2.2 Theorical solution graph code:

```
>> %Theorical solution graph
x=0:11;
y1=(-0.9/10.95)*x+0.9;
y2=(0.9/10.95)*x-0.9;
hold on
plot(x,y1)
plot(x,y2)
```

2.3 Matlab code of core part results:

2.3.1 Graph at 10 m/s:

```
%Velocidad 10m/s.
A=xlsread('Finalresults.ods', 'Hoja1','A2:B703')
Y=A(:,2);
X=A(:,1);
B=xlsread('Finalresults.ods', 'Hoja1','E2:E703')
Z=B(:,1);
plot3(X,Y,Z)
```

2.3.2 Graph at 25 m/s:

```
%Velocidad 25m/s.
A=xlsread('Finalresults.ods', 'Hoja2','A2:B703')
Y=A(:,2);
X=A(:,1);
B=xlsread('Finalresults.ods', 'Hoja2','E2:E703')
Z=B(:,1);
plot3(X,Y,Z)
```

2.3.3 Graph at 45 m/s:

```
%Velocidad 45m/s.
A=xlsread('Finalresults.ods', 'Hoja3','A2:B244')
Y=A(:,2);
X=A(:,1);
B=xlsread('Finalresults.ods', 'Hoja3','E2:E244')
Z=B(:,1);
plot3(X,Y,Z)
```

2.4 Matlab code of final results:

2.4.1 Three velocity result graph:

```
>> %Finalresults velocities
A1=[4 4 4 5 5 5 6 5 6 6 6 6 7 7 7 7 7 8 8 9 9 8 9 10 9 9]
A2=[21 21 21 21 20 20 20 20 20 20 19 19 18 18 18 18 18 17 17 17 16 18 18 17 16 15]
B1=[4 4 4 5 5 5 5 5 6 6 6 7 7 7 7 8 8 8 8 9 9 9 9 9 9 10 10]
B2=[21 21 21 21 20 20 20 20 20 19 19 18 18 18 18 18 17 17 17 17 17 16 16 16 16 16]
C1=[4 4 4 5 5 5 5 5 6 6 6 6  8 8 8 8 8 8 8 8 9 9 9 9 9 9]
C2=[21 21 21 20 20 20 20 20 19 19 19 19 18 18 18 18 18 18 18 18 16 16 16 16 16 16]
D=[0 25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500 525 550 575 600 625]
hold on
plot(D,A1)
plot(D,A2)
plot(D,B1)
plot(D,B2)
plot(D,C1)
plot(D,C2)
hold on
```

2.4.2 Medium result graph:

```
>> %Finalresults medium
F1=[4 4 4 5 5 5 5 5 6 6 6 6 7 7 7 8 8 8 8 9 9 9 9 10 10 10]
F2=[21 21 21 21 20 20 20 20 20 19 19 19 18 18 18 18 18 17 17 17 16 16 16 16 16 15]
D=[0 25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500 525 550 575 600 625]
plot(D,F1)
plot(D,F2)
```