conditions were obtained. Commencing the measurements depends on the degree of temperature stabilisation. The condition is considered steady when the temperature is the same within 2% between two consecutive readings of the measurements. The stationary state is reached after approx. 15 minutes. Then the measurements of air velocity along the determined measurement lines using thermoanemometric probes are started. The duration of the measurement, in which the mean air velocity result was obtained, amounted to 3 minutes. After these measurements, further measurements are taken for the subsequent air streams/air velocities flowing through the diffuser. Then the entire measurement procedure is repeated from the beginning .

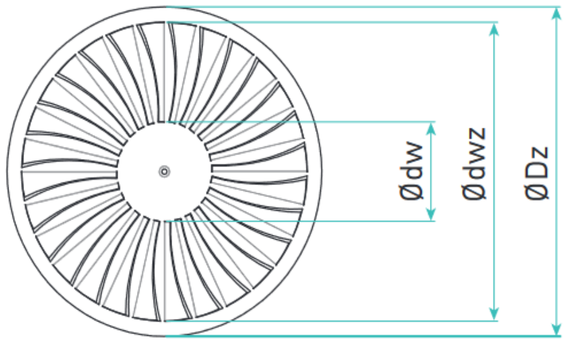


**Fig. 4.** Simulated diffusers geometry.

The diffusers used in experimental analysis are made in four sizes: 300, 400, 500, 600 mm. Each of them has different dimensions, which are presented in Table 1.

**Table 1.** List of the characteristic dimensions of diffusers.

| Size | *dw* | *dwz* | *Dz* |
|---|---|---|---|
| | mm | mm | mm |
| 300 | 85 | 250 | 300 |
| 400 | 115 | 350 | 400 |
| 500 | 150 | 450 | 500 |
| 600 | 180 | 550 | 600 |

## 3 Results and discussion

The measurements for the size 300 diffuser were made for 6 air flow rates V=100, 150, 200, 250, 300 and 350 $m^3/h$. The measurements were made at eight points with thermoanemometers suspended on a horizontal crossbar from X=0.0 m to X=2.7 m. The measurement points (thermoanemometers) were located at a distance of 0.3 m from each other. The first thermoanemometer was located on the axis of the diffuser X=0.00 m; Z=0.05 m.

Figure 5 shows an example of the velocity distribution for the air flow rates equal to V=250$m^3/h$. It can be infer from the figure that the largest changes in the air flow occur at the distance from the false ceiling in the plane Z=0.05 m. At a larger greater distance from the ceiling, the air velocity is smaller than 0.2 m/s. The analysis shows that the air stream range for the speed of 0.2 m/s equals $L_{0.2}$ = 2.5 m. It should be noted that the diffuser has a significant air stream range.

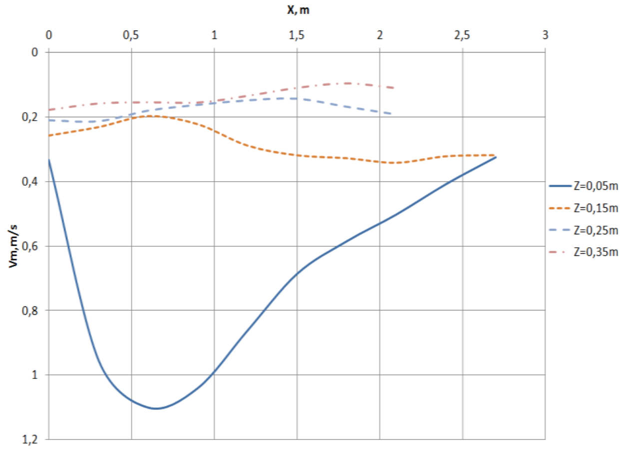


**Fig. 5.** Velocity distribution for a size 300 diffuser for the air flow rate V=250$m^3/h$.

Due to the fact that the most significant changes take place on the plane Z=0.05m, Figure 6 shows the summary breakdown of the velocity distributions for different air flow rates. This figure shows that the maximum velocity in this plane occurs at a horizontal distance of about 0.75 m and then decreases to disappear at a distance of 1.4 m to 3.5 m, depending on the actual air flow rate.

Figure 7 presents the air velocity profile of the air flowing out of the size 300 diffuser in the plane of Z=0.05 m from the ceiling and for the flow rate equal to V=100$m^3/h$. This figure shows the characteristic shape of the velocity profile from the diffuser.

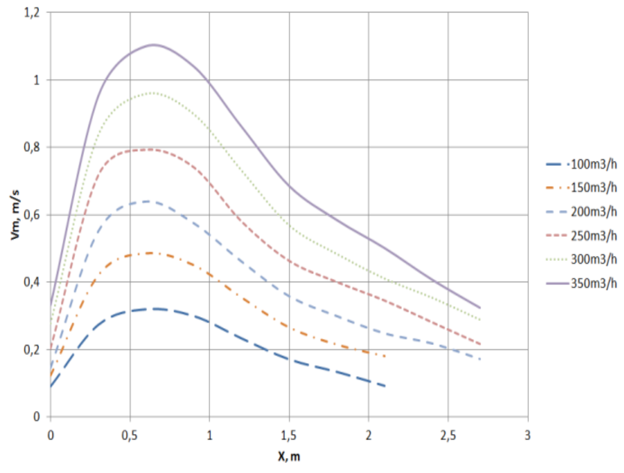


**Fig. 6.** Velocity distribution for a size 300 diffuser for different air flow rates and in the plane Z=0.05 m.

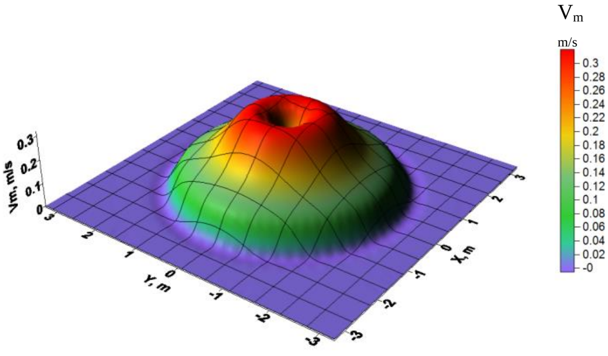


**Fig. 7.** Velocity profile for a size 300 diffuser in the plane Z=0.05 m for air flow rate V=100 m³/h.

### 3.1 Description of the air flow from the ceiling diffuser

Figure 8 presents the distribution of velocity from the vortex diffuser with the blades at an angle of 45°. The swirl of the air stream from this diffuser causes the air stream to spread under the ceiling. It seems that the vertical range of the diffuser is low. However, the horizontal range is significant with such a small stream of air and dimensions of the diffuser. This is a signal of the high efficiency of air distribution in the room. One can also observe the swirling motion of the air in the room.

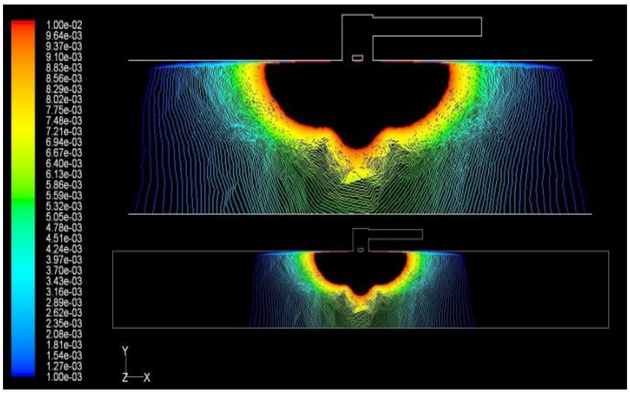

**Fig. 8.** Vortex diffuser air velocity iso-lines for $V_m$ = 0.65 m/s.

### 3.2 Diffuser velocity decay coefficient

The performance of the jet created by the diffuser can be characterized by a single constant, namely jet velocity decay coefficient *K*. It can be defined as [11]:

$$\frac{V}{V_o} = K\frac{\sqrt{A_o}}{x} \tag{1}$$

The diffuser velocity decay coefficient *K* can be determined by plotted the dimensionless velocity $V/V_o$ versus the dimensionless distance $x/sqrt\,(A_o)$ as shown in Figure 9 where the values of the decay coefficient can be directly determined when the curve intersects the dimensionless velocity at the unity (i.e. $V/V_o$=1). The value of the velocity decay coefficient is 1.6.

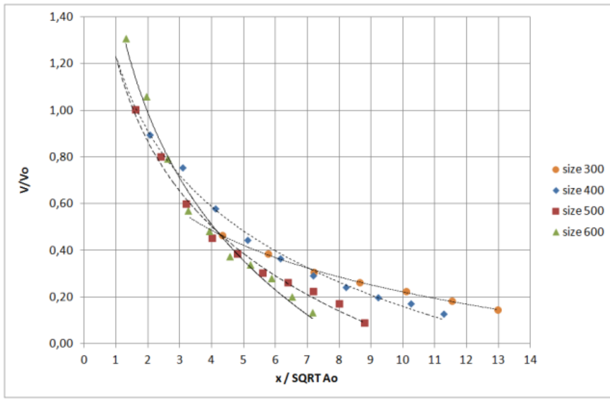


**Fig. 9.** Dimensionless velocity for different size for vortex diffuser

## 4 Conclusion

This article presents the results of experimental and numerical studies for different air flow rates and thus different inlet velocities of air into a vortex diffuser.

The velocity vector of the studied vortex diffuser is mainly directed horizontally under the ceiling. The long range is achieved by the swirling movement of the air leaving the diffuser. After the air is distributed under the ceiling, it drops, and the heat gains in the room are observed. In this way, the comfort conditions in the room are effectively ensured. Due to the high horizontal air range, no dead zones are formed in the room. The airflow is also distributed in such a way that the air circulation in the room is reduced. It can be seen that the vortex diffuser is characterised by high efficiency of indoor air distribution.

The buoyancy force has a significant impact on the temperature and velocity field, the diffuser creates a thermal comfort zone with a large radius.

The airflow range for the 300 size vortex diffuser for 0.2 m/s is in the range $L_{0.2}$=1.4-3.5 m. The diffuser has a large range of the air stream.

The maximum velocity under the false ceiling is about 0.75 m horizontally and then decreases to the loss of flow V=0.2 m/s depending on the air stream value.

The pressure coefficient rises sharply for a Reynolds number of less than Re=10,000. An analysis of the dimensionless mean velocity $V_m/V_o$ in relation to the Reynolds Number Re shows that it also rises below 10,000. For small airflows and thus low Reynolds numbers, it is difficult to ensure the correct air stream profile and indoor air distribution and thus the right conditions for thermal comfort.

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