# PLASMAMADE B.V. NETHERLANDS

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## Explanation of pressure drop with different channels or recirculation solutions.


**AUTHOR & PERFROMANCE**

K.R. van der Sluis en M.J. van der Sluis

**PlasmaMade B.V.** Netherlands


**SUMMARY:**


In this document we want to show what the pressure drop is for different channels and recirculation solutions. We also want to demonstrate the consequences for the extraction capacity and the motor / fan choice.


**INDEX:**

# Introduction.

In this document we would like to explain and show what the pressure drop is for different solutions of exhaust or filtering the air. This is often achieved by means of an extractor hood or extraction system. The main options are a channel to the outside or recirculation in the room. Various solutions are possible under recirculation, such as, for example, carbon modules or plasma filters.

In this document we deal with the channels that are commercially available as standard, which you will also find later in this document in, among other things, the pressure drop diagram. We had the support of EBM Papst in making this document. EBM Papst is a leading fan / motor supplier which is used by the vast majority of extractor manufacturers as a supplier for their motors.

**One of the main research questions is: could a motor break down due to pressure drop in the ductwork, or due to pressure drop with the use of recirculation filters?**

In this document we have not included the pressure drop of the different grease pre-filters, because it differs per extractor. A grease pre-filter will always contribute to a higher back pressure, because the closer the filter the higher the back pressure, it is expressed in PA (Pascal). The higher the pressure in the system, the less m3 / h the fan / motor produces (due to pressure loss).

In ductwork we talk about "the resistance" and / or "the back pressure", this means the pressing force on the surface. When the air flows through the ducts / pipes / channels, it experiences friction against the walls, it encounters obstacles, must change direction due to branches, widenings, constrictions, etc. With a fan, the pressure is displayed in Pascal (Pa). The higher the pressure in a system, the less capacity in m3 / h the fan produces (pressure loss).

Then we have the static pressure (PE), which is the force that the air exerts in all directions and on the entire surface of the walls. And then there is also the dynamic pressure (PD), which is the force that causes the air to accelerate from 0 meters per second to the actual speed (m / s) in the channels of the complete system.

In the end we talk about total pressure (PT), which is the sum of the static pressure and the dynamic pressure (PT = PE + PD).

We can also link the volume to this. Sound is a mechanical vibration / vibration that produces an audible sensation and propagates through waves. Fans obviously make noise, which has to do with the running of the motor and the noise of the displaced air volume. In any case, avoid resonance (vibrations from the fan passing through the system), often caused by imbalance. Resonance greatly amplifies the fan noise. We can say that: the higher the pressure in Pascal (Pa), the higher the sound of the fan (the pressure compensation of motors will automatically increase the speed).

# 2. Measurement results.

The diagrams below show the various options available for connecting an extractor hood and / or an extractor system. First of all, we are talking about processing the cooking air (air to be extracted) outwards by means of an extractor hood and / or extraction system. We made the calculations with 3 meters of ductwork (see different diameters). Starting with a 50 cm flexible hose which is connected to the exhaust nozzle of the engine, then three times one meter straight duct with two bends of 90 degrees, a non-return valve (butterfly valve with springs) and an outside wall grille. We have assumed a fairly ideal situation in these diagrams, we know that in reality it is often different. In practice, the number of meters of channels and the number of bends used are often a multiple of the situations depicted here. The longer the ductwork, the use of extra bends and the making of bends with a flexible hose, the back pressure / resistance in Pa (pascal) will increase proportionally, as will the energy consumption of the extractor hood.

The diameters and dimensions of the channels are shown visually in diagrams of figure [1] [2] [3].

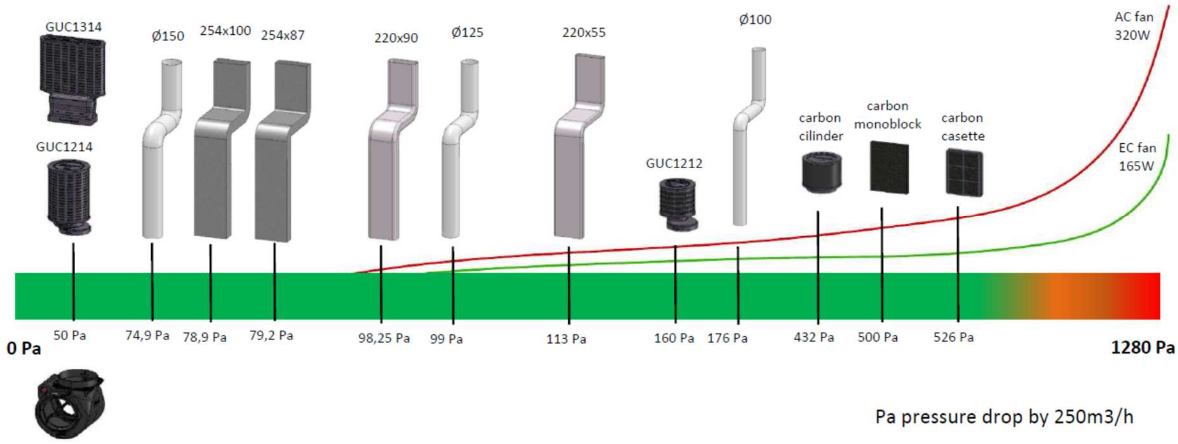
The first recirculation option included the 3 different PlasmaMade models, the GUC1214, GUC1314 and the GUC1212.

the two models, GUC1214 and GUC1314, are both suitable for extractor hoods with a maximum extraction capacity of 1000m3 / h. The smaller GUC1212 is suitable for extractor hoods with a maximum extraction capacity of 600m3 / h. In the attached diagrams you can see the different pressure drops measured by EBM Papst in Germany, among others.

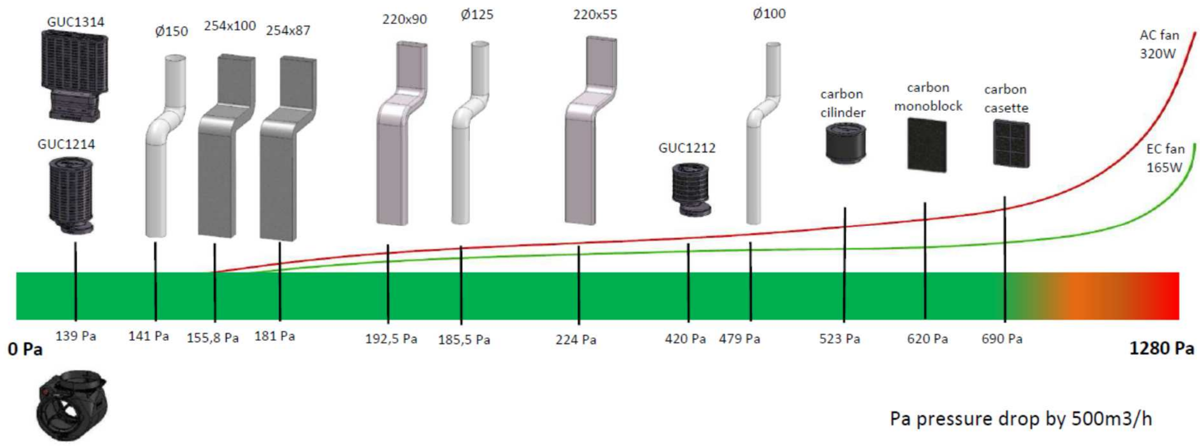
As a second recirculation option, three standard carbon filters have been included, which may include the square / rectangular cassettes. These cassettes are often placed in front of the engine (pull system). As a second carbon option, we consider the long life carbon blocks. These long life carbon blocks are mounted in the shaft after the engine (push system). As a third and last option we treat the carbon cartridges / cylinders which are mounted directly on the exhaust nozzle of the engine (push system). We have not been able to obtain and / or find the pressure drop in Pa from all manufacturers in this document. We would get hundreds of different types, but the outcome will not differ much. We also did not include the pollution by means of grease, dirt and moisture. It is clear that the pressure (and sound) due to pollution will increase enormously as the filter ages. We will not consider the operating time of a carbon filter here.

*Examples of two carbon cassettes and a carbon block*

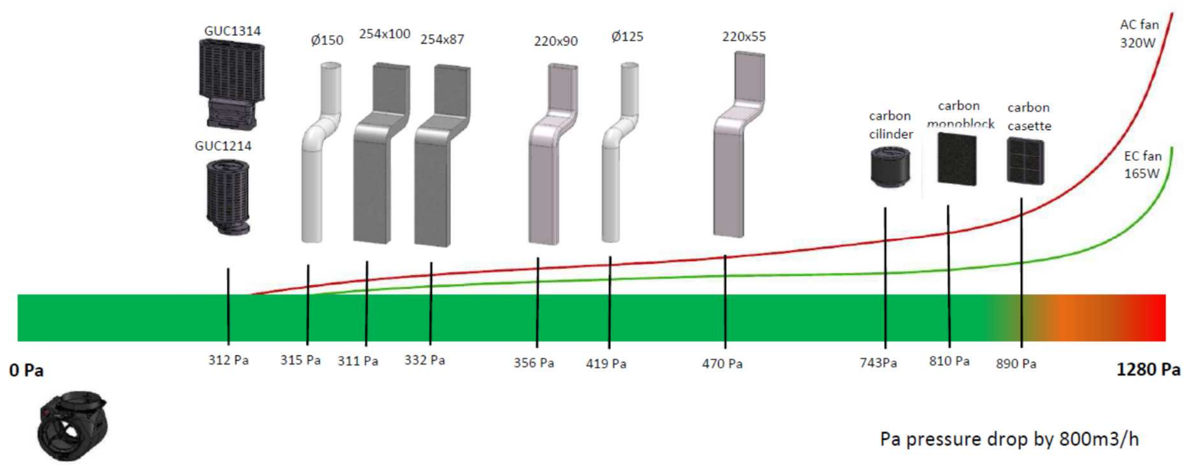
Figures [1] [2] [3], shown below, show a color bar from green to red. In the red part, the pressure drop is so great that the extractor hood no longer extracts and the motor runs in its own air (no more suction and no more blowing). Research, at EBM Papst, among others, shows that this **has no destructive consequences** for the fan / motor.




*Figuur 1 Pressure drop by 250m3/h*




*Figuur 2 Pressure drop by 500m3/h*




*Figuur 3 Pressure drop by 800m3/h*

## 3. Conclusion.

This investigation has shown that with various solutions for connecting a hood and / or extraction system, the motor power and the type of motor installed therein are important for the operation of the relevant hood and / or extraction system. Ultimately, it is important that the air is guided as aerodynamically as possible through the channel or recirculation filter, this has the positive purpose that you can move more air with less resistance and which ultimately also has a positive effect on the sound. It is also important that the right conditions are taken into account, so when extracting the air outside, the power in cubic meters per hour (m3 / h) is very important so that you only get **one chance** to discharge the air. Always make sure here that the air that goes out must also be brought back in. If there is no "clean air supply", you will get an underpressure, and the extractor hood will no longer have air to suck, causing the operation to stop. It works differently with recirculation. When recirculating, it is important to use the extractor hood or extractor at the lowest or second position. The capacity of the extractor hood can and may be less, up to 600m3 for example. These lower values are possible because the ideal situation with recirculation is around 200 to 300 m3 / h (lowest and second position). Today's so-called recirculation hoods / systems usually already meet these new standards.

**The main question in this study is: is an extractor hood or exhaust system motor defective due to too high a back pressure (Pa)?** This question has also been returned to EBM Papst, among others. The answer is a definite NO, because these engines are usually built to compensate for pressure (Pa) up to 1350-1500 PA (engines in extraction systems). The diagram above also shows that none of the commonly used solutions do not reach these high back pressures (Pa). Even if the static and dynamic air are included in the calculations. What happens if the engine is nevertheless loaded with back pressures that are higher than the engine can handle? The answer is actually very simple and obvious. The answer can also be read in the diagrams of both engines separately (see curves of EBM Papst appendices). The engine then runs in "its own air" (no suction and no blowing) and will no longer extract, an engine cannot and will not break. As already indicated in the diagram of the different channels, the motor / fan cannot break if a smaller diameter is connected. Only the back pressure in Pa increases, so this has nothing to do with the fact that an engine can break, if that were the case, any extractor hood with a carbon filter would fail in the foreseeable future as the back pressure / resistance that a carbon cassette supplies are on the high side. In addition, each motor is protected by EBM Papst with a thermal protection, if it gets too hot, the motor will first switch off and switch on again after it has cooled down. EBM Papst indicates that due to back pressure, the thermal protection never gets so hot that it must intervene. Thermal protections, however, often operate in the event of fire and / or excessive temperatures from the extractor hood and / or environment.

The development of motors / fans also takes into account the application of the motor concerned, the same applies to the manufacturers of ducts and recirculation solutions. We always strive for the lowest possible resistance (good aerodynamics) to save energy and reduce noise. This is also the reason that more and more EC controlled motors are used. EC motors use less energy and produce less noise, so we are able to build recirculation filters that in the new energy-poor appliances only need to have 300 m3 / h extraction capacity. Due to the low m3 / h in combination with a lower air speed, the resistance is lowered and this again benefits the energy consumption and the sound intensity.

# 4. References.

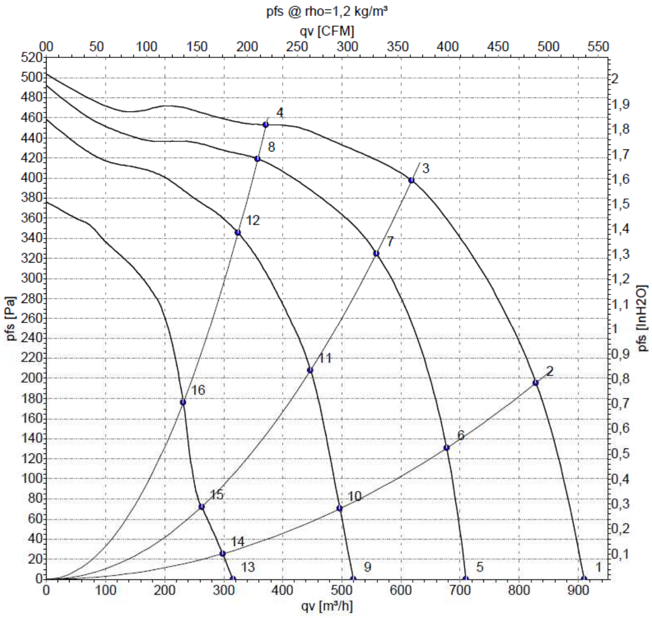
**D2E146-HT59-02**

# AC centrifugal fan

forward-curved, dual-intake

with housing (flange)

## Curves: Air performance 50 Hz




Measurement: LU-156752-1
Measurement: LU-156754-1
Measurement: LU-156757-1
Measurement: LU-156762-1

Air performance measured according to ISO 5801 installation category A. For detailed information on the measurement setup, contact ebm-papst. Intake sound level: Sound power level according to ISO 13347 / sound pressure level measured at 1 m distance from fan axis. The values given are valid under the specified measuring conditions and may vary due to conditions of installation. For deviations from the standard configuration, the parameters have to be checked on the installed unit.

## Measured values

| | U | f | n | $P_e$ | I | $LpA_{in}$ | $LwA_{in}$ | $q_V$ | $p_{fs}$ | $q_V$ | $p_{fs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | V | Hz | $min^{-1}$ | W | A | dB(A) | dB(A) | $m^3/h$ | Pa | cfm | inH2O |
| 1 | 230 | 50 | 1600 | 290 | 1.28 | 62 | 73 | 910 | 0 | 535 | 0.00 |
| 2 | 230 | 50 | 2020 | 256 | 1.12 | 61 | 73 | 830 | 200 | 490 | 0.80 |
| 3 | 230 | 50 | 2420 | 203 | 0.89 | 60 | 72 | 620 | 400 | 365 | 1.61 |
| 4 | 230 | 50 | 2645 | 161 | 0.70 | 63 | 74 | 370 | 450 | 220 | 1.81 |
| 5 | 230 | 50 | 1280 | 247 | 1.08 | 56 | 67 | 710 | 0 | 420 | 0.00 |
| 6 | 230 | 50 | 1665 | 226 | 0.99 | 56 | 68 | 675 | 133 | 400 | 0.53 |
| 7 | 230 | 50 | 2210 | 183 | 0.83 | 59 | 70 | 560 | 325 | 330 | 1.30 |
| 8 | 230 | 50 | 2550 | 140 | 0.66 | 63 | 74 | 360 | 421 | 210 | 1.69 |
| 9 | 230 | 50 | 960 | 203 | 0.89 | 48 | 59 | 520 | 0 | 305 | 0.00 |
| 10 | 230 | 50 | 1235 | 196 | 0.87 | 49 | 60 | 495 | 70 | 295 | 0.28 |
| 11 | 230 | 50 | 1805 | 174 | 0.78 | 53 | 65 | 445 | 214 | 265 | 0.86 |
| 12 | 230 | 50 | 2330 | 133 | 0.63 | 60 | 71 | 325 | 345 | 190 | 1.39 |
| 13 | 230 | 50 | 595 | 163 | 0.72 | 36 | 47 | 315 | 0 | 185 | 0.00 |
| 14 | 230 | 50 | 765 | 160 | 0.71 | 36 | 47 | 300 | 26 | 175 | 0.10 |
| 15 | 230 | 50 | 1065 | 154 | 0.68 | 40 | 52 | 265 | 72 | 155 | 0.29 |
| 16 | 230 | 50 | 1675 | 138 | 0.63 | 51 | 62 | 230 | 181 | 135 | 0.73 |

U = Power supply · f = Frequency · n = Speed (rpm) · $P_e$ = Power consumption · I = Current draw · $LpA_{in}$ = Sound pressure level intake side · $LwA_{in}$ = Sound power level intake side

$q_V$ = Air flow · $p_{fs}$ = Pressure increase

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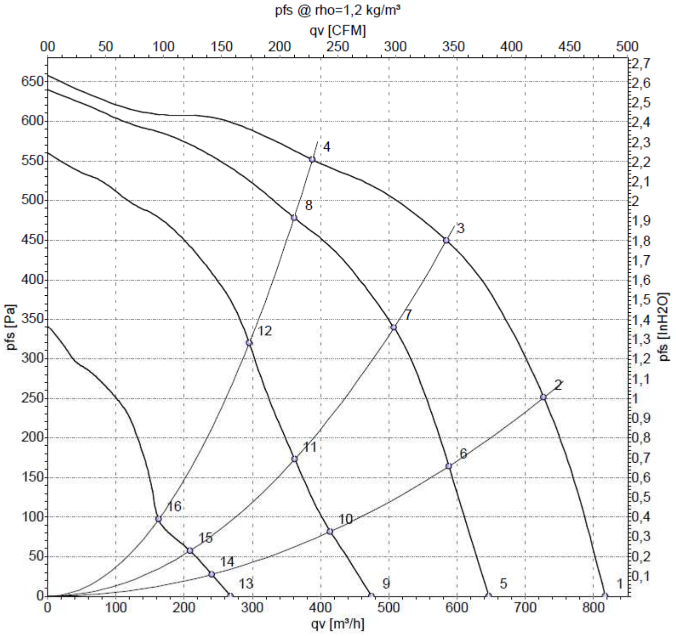
# AC centrifugal fan

forward-curved, dual-intake

with housing (flange)

## Curves: Air performance 60 Hz




Measurement: LU-156771-1
Measurement: LU-156772-1
Measurement: LU-156773-1
Measurement: LU-156774-1

Air performance measured according to ISO 5801 installation category A. For detailed information on the measurement setup, contact ebm-papst. Intake sound level: Sound power level according to ISO 13347 / sound pressure level measured at 1 m distance from fan axis. The values given are valid under the specified measuring conditions and may vary due to conditions of installation. For deviations from the standard configuration, the parameters have to be checked on the installed unit.

## Measured values

| | U | f | n | $P_e$ | I | $LpA_{in}$ | $LwA_{in}$ | $q_V$ | $p_{fs}$ | $q_V$ | $p_{fs}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | V | Hz | $min^{-1}$ | W | A | dB(A) | dB(A) | $m^3/h$ | Pa | cfm | inH2O |
| 1 | 230 | 60 | 1500 | 320 | 1.40 | 60 | 71 | 815 | 0 | 480 | 0.00 |
| 2 | 230 | 60 | 2085 | 296 | 1.28 | 60 | 71 | 725 | 250 | 430 | 1.00 |
| 3 | 230 | 60 | 2570 | 267 | 1.17 | 62 | 73 | 585 | 450 | 345 | 1.81 |
| 4 | 230 | 60 | 2930 | 236 | 1.06 | 65 | 77 | 390 | 550 | 230 | 2.21 |
| 5 | 230 | 60 | 1170 | 254 | 1.11 | 54 | 65 | 645 | 0 | 380 | 0.00 |
| 6 | 230 | 60 | 1685 | 244 | 1.08 | 54 | 66 | 590 | 164 | 345 | 0.66 |
| 7 | 230 | 60 | 2260 | 221 | 1.01 | 59 | 70 | 505 | 339 | 300 | 1.36 |
| 8 | 230 | 60 | 2720 | 188 | 0.92 | 64 | 75 | 360 | 477 | 210 | 1.91 |
| 9 | 230 | 60 | 875 | 204 | 0.92 | 46 | 57 | 475 | 0 | 280 | 0.00 |
| 10 | 230 | 60 | 1225 | 197 | 0.89 | 46 | 56 | 415 | 81 | 245 | 0.33 |
| 11 | 230 | 60 | 1640 | 192 | 0.88 | 51 | 62 | 360 | 173 | 215 | 0.69 |
| 12 | 230 | 60 | 2255 | 169 | 0.82 | 59 | 70 | 295 | 320 | 175 | 1.28 |
| 13 | 230 | 60 | 515 | 157 | 0.72 | 29 | 40 | 270 | 0 | 160 | 0.00 |
| 14 | 230 | 60 | 730 | 153 | 0.70 | 30 | 41 | 240 | 28 | 140 | 0.11 |
| 15 | 230 | 60 | 955 | 151 | 0.69 | 36 | 47 | 210 | 57 | 120 | 0.23 |
| 16 | 230 | 60 | 1245 | 147 | 0.68 | 42 | 53 | 165 | 93 | 95 | 0.37 |

U = Power supply · f = Frequency · n = Speed (rpm) · $P_e$ = Power consumption · I = Current draw · $LpA_{in}$ = Sound pressure level intake side · $LwA_{in}$ = Sound power level intake side
$q_V$ = Air flow · $p_{fs}$ = Pressure increase



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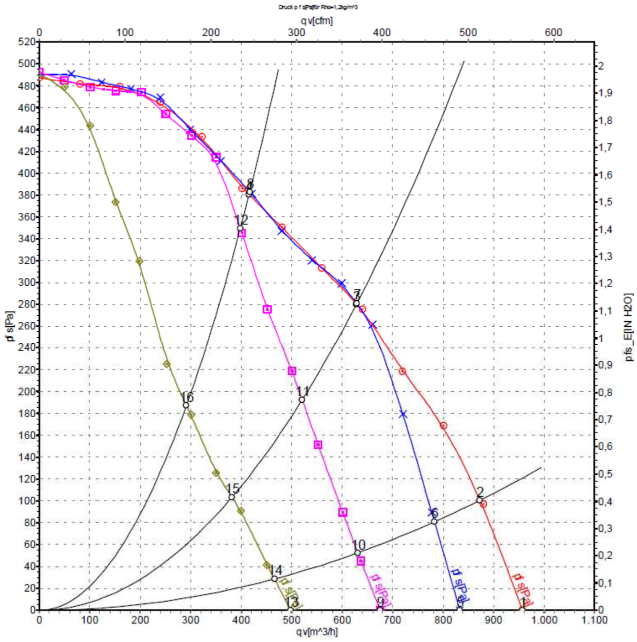
# EC centrifugal fan

forward curved, dual inlet

with housing (large flange)

## Charts: Air flow 50 Hz



Measurement: LU-132080
Measurement: LU-132083
Measurement: LU-132084
Measurement: LU-132086

Air performance measured as per ISO 5801 Installation category A. For detailed information on the measuring set-up, please contact ebm-papst. Suction-side noise levels: LwA measured as per ISO 13347 / LpA measured with 1m distance to fan axis. The values given are valid under the measuring conditions mentioned above and may vary according to the actual installation situation. With any deviation from the standard set-up, the specific values have to be checked and reviewed with the unit installed.

## Measured values

| | U | f | n | $P_{ed}$ | I | qv | $P_{fs}$ |
|---|---|---|---|---|---|---|---|
| | V | Hz | $min^{-1}$ | W | A | $m^3/h$ | Pa |
| 1 | 230 | 50 | 1610 | 165 | 1.30 | 955 | 0 |
| 2 | 230 | 50 | 1830 | 165 | 1.30 | 875 | 100 |
| 3 | 230 | 50 | 2165 | 134 | 1.06 | 630 | 280 |
| 4 | 230 | 50 | 2445 | 110 | 0.89 | 415 | 380 |
| 5 | 230 | 50 | 1390 | 100 | 0.80 | 835 | 0 |
| 6 | 230 | 50 | 1640 | 113 | 0.91 | 785 | 81 |
| 7 | 230 | 50 | 2175 | 136 | 1.07 | 630 | 281 |
| 8 | 230 | 50 | 2450 | 110 | 0.90 | 415 | 383 |
| 9 | 230 | 50 | 1130 | 50 | 0.43 | 675 | 0 |
| 10 | 230 | 50 | 1325 | 59 | 0.49 | 630 | 52 |
| 11 | 230 | 50 | 1810 | 73 | 0.61 | 520 | 192 |
| 12 | 230 | 50 | 2345 | 94 | 0.76 | 400 | 350 |
| 13 | 230 | 50 | 865 | 22 | 0.21 | 500 | 0 |
| 14 | 230 | 50 | 1000 | 25 | 0.23 | 465 | 28 |
| 15 | 230 | 50 | 1360 | 32 | 0.28 | 380 | 103 |
| 16 | 230 | 50 | 1740 | 40 | 0.35 | 290 | 187 |



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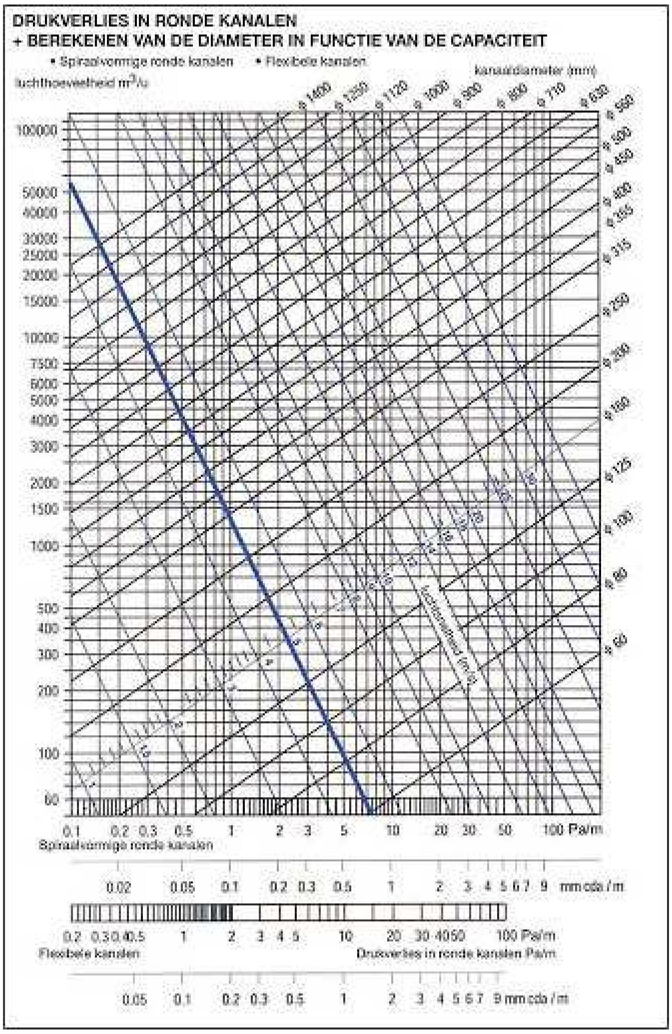

DRUKVERLIES IN RONDE KANALEN
+ BEREKENEN VAN DE DIAMETER IN FUNCTIE VAN DE CAPACITEIT
• Spiraalvormige ronde kanalen • Flexibele kanalen
luchthoeveelheid m³/u
kanaaldiameter (mm)
ϕ 1400 ϕ 1250 ϕ 1120 ϕ 1000 ϕ 900 ϕ 800 ϕ 710 ϕ 630 ϕ 560 ϕ 500 ϕ 450 ϕ 400 ϕ 355 ϕ 315 ϕ 250 ϕ 200 ϕ 160 ϕ 125 ϕ 100 ϕ 80 ϕ 60
100000 50000 40000 30000 25000 20000 15000 10000 7500 6000 5000 4000 3000 2000 1500 1000 500 400 300 200 100 60
0.1 0.2 0.3 0.5 1 2 3 5 10 20 30 50 100 Pa/m
Spiraalvormige ronde kanalen
0.02 0.05 0.1 0.2 0.3 0.5 1 2 3 4 5 6 7 9 mm cda / m
0.2 0.3 0.4 0.5 1 2 3 4 5 10 20 30 40 50 100 Pa/m
Flexibele kanalen
Drukverlies in ronde kanalen Pa/m
0.05 0.1 0.2 0.3 0.5 1 2 3 4 5 6 7 9 mm cda / m