2016

# AIR BLOWING MACHINERY

## and technical solutions based on them

## Air blowing machinery and technical solutions on their basis

The publication examines the technical solutions of the Chelyabinsk compressor plant to supply large volumes of air with low pressure, highlights the major component operation principles - Ruts-compressor air pressurization systems, their nomenclature and basic specifications.

*Scientists study what*
*Property Features*
*engineers create something*
*what never was.*
A Einstein.

.

## Dear Colleagues!

Our factory, with years of experience for creating and implementing a compressor technology for industry, in cooperation with leading European manufacturers of Air blowing machinery has mastered production of compressor units and stations, the heart of which is a 3-tooth gear positive displacement compressor of Ruts. The main purpose of these compressors is the creation of a large air flow with low overpressure, typically no more than one atmosphere, for which they received the nickname "blowers".

To date, there is a great need for domestic enterprises in blower machines, due to 2 factors:

- the State program of import substitution, enabling purchase of products domestic producers;
- modernization, caused by the need to reduce operating costs by replacing old equipment for modern, more energy efficient, perfect.

Our factory is willing to offer a wide range of plants and stations, the principles of construction and operation of which the main advantages, features and specifications are disclosed in this publication.

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# RUTS'S POSITIVE DISPLACEMENT COMPRESSOR

## Design features

**The gear positive displacement compressor with the original teeth profile** was invented in 1859 by Ruts brothers. At that time gear application in all industries was quite popular. In the case of mechanical transmission and pumps the gear almost did not lose its classic look. In the case of the compressor significant reduction of working volume and, as a consequence, air compressing in the Chamber were required to provide. Classic gear did not give such an effect due-to the large number of teeth and, as a consequence, small volume occupied by them in the discharge Chamber. The Ruts brothers solved the problem by reducing the number of gears up to 2 and giving them greater dimensions. The task of gear compressor creating was performed.

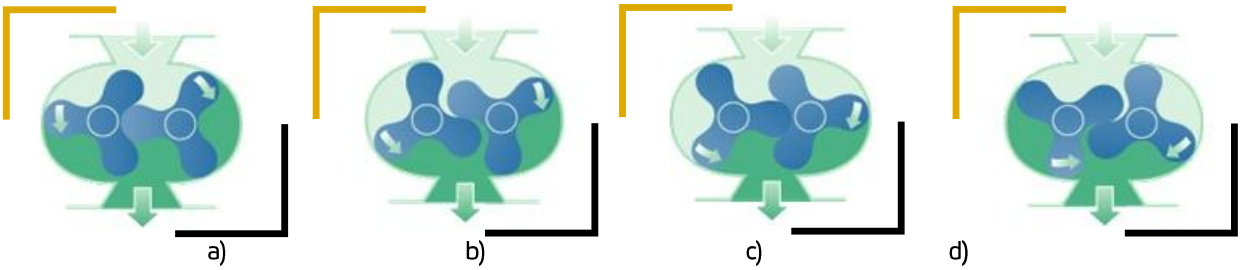
**Ruts's positive displacement compressor**, being gear mechanism, belongs to the positive displacement compressor class, the distinctive features of which are 4:

1. Availability in pulsatory assembly of the stator, rotor, closer, and displacer.
2. **Separation of suction** and discharge chambers.
3. Medium **dosen** charge.
4. **Small dependence of charge on discharge** pressure due to work volume high air-tightness.

The compressor body is the stator, the gear shaft if the rotor, tooth is closer and displacer at the same time. Due to the small number of teeth (2 or 3) sufficient tightness of work volume that is comparable with integrity of classic gear pump is not provided, that results to internal leakage increasing with discharge pressure growth. Low-viscosity handled medium (air or gas) as well as gear mesh lack due to minimum clearance are conductive to this. Property to develop greater performance only at low working pressure contributed to that the Ruts's compressors became known as blowers.

## Discharge principle

Modern positive displacement compressors have 3-teeth gears which are synchronized by classical gears located outside of work volume (**a**). In the suction Chamber (upper) teeth detach, increasing its volume and sucking air. Getting in the volume between the toothed gears, air moves to the discharge Chamber (bottom).

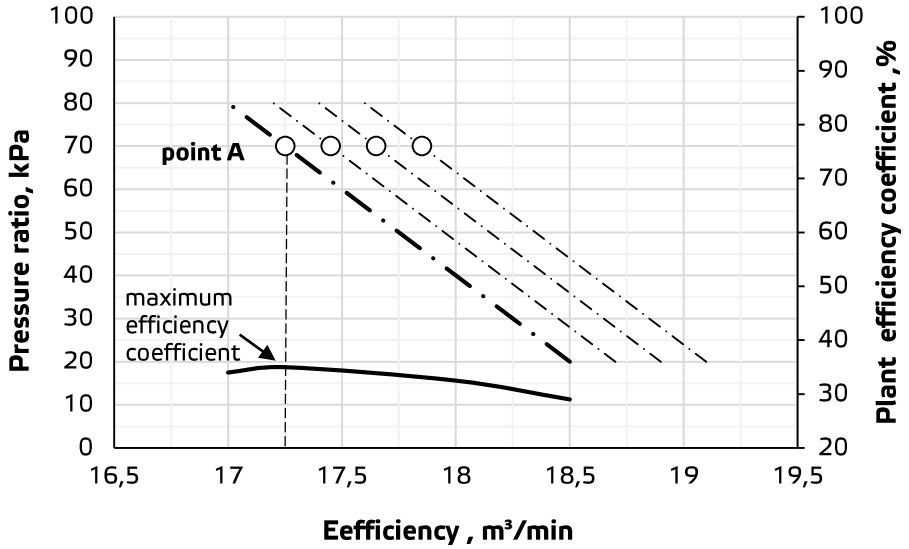



At the beginning the volume with left gear is open in the discharge chamber (**b**). When its tooth comes in root of the right fear, air is forced out. Similarly, air displacement is made by the right gear (**d**). In its pure form portion of the filing is weak, and ripple inherent in volumetric machines, due to the low working pressure there is virtually no.

In gears rotating there are times when the discharge and suction Chamber are shared only by one tooth (**a** – the left gear and body, **b** – the right gear and case). At this moment the air leakages from discharge zone to suction zone increase. In addition, the minimum clearance between the gear teeth results to permanent leakage through the compressor central part.

## Working point and field characteristics

Each compressor has its individual characteristics, reflecting its dependence of productivity **Q**, m3/min, from output pressure (load) **p**, kPa (bar-dotted line). The characteristics of the installation efficiency, % (solid line) are together with individual characteristic. Machine Working **point A** corresponds to performance nominal values (17.25 $m^3$/min ) and pressure (70 kPa), at this point the efficiency coefficient is maximum. It is imperative that during operation the plant parameters are near the working point, ensuring that efficiency coefficient is near the maximum.




**To cover wider range of performance at given pressure drop**, different transmissions are chosen for the same compressor. Increase or decrease of their ratio results in a corresponding increase or decrease the compressor performance.

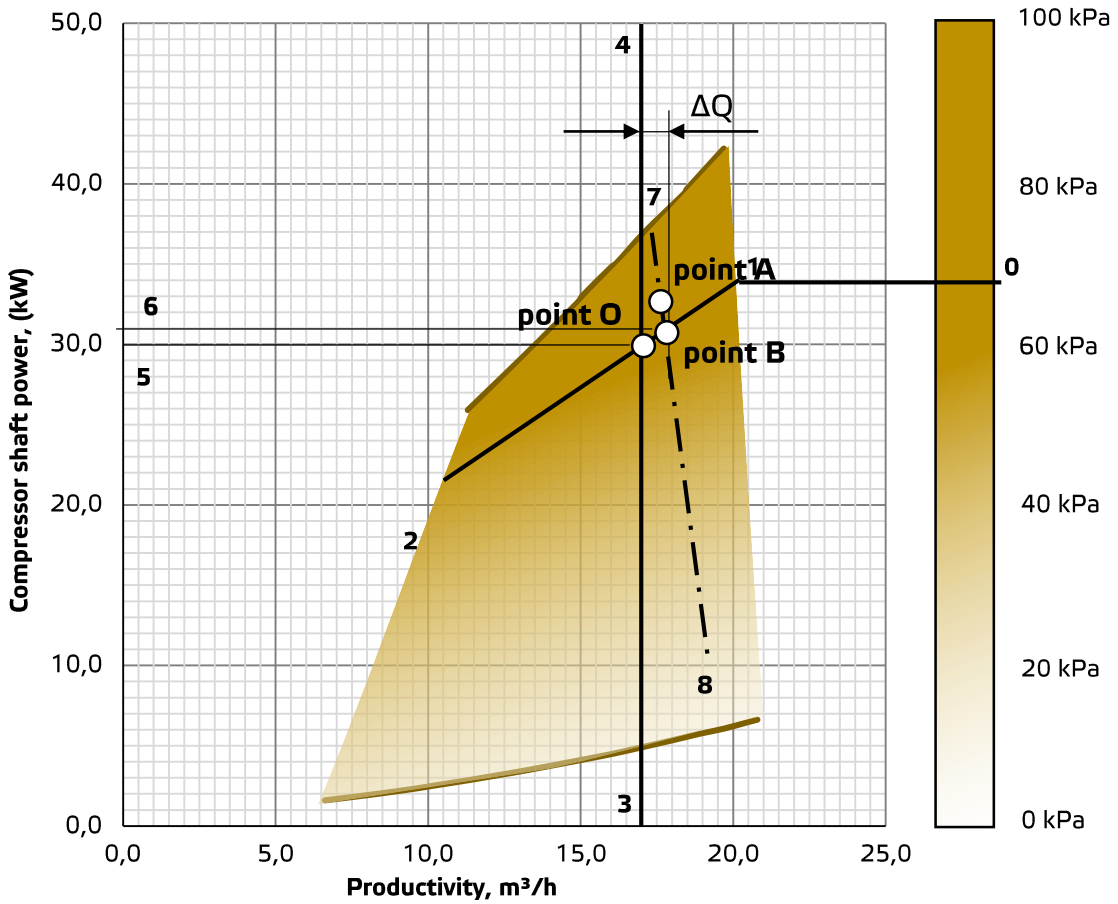
In order to increase productivity and to keep the torque of the compressor shaft it is necessary to install a more powerful drive motors. It forms the **compressor dimension range for specific pressure drop at the same compressor**, but by different speeds of its rotors (transmissions) and various consumable capacities (drive motors). Each of these installations has individual characteristic in specific working point (thin dashed-dotted lines) and individual efficiency characteristic (not shown).

The line passing through the working points of these characteristics is **line one pressure drop**. The dimension range is created not only for different capacities, but also to various pressure differences. Thus, compressor plants, based on the same compressor, **appears characteristics** field produced by many working points. To enhance field information content , pressure vertical scale is replaced by wattage scale, and each line of one pressure drop is signed directly on the chart (see annex A).

**Ideally, the manufacturer can create any plant** based on field bounded by lines of minimum and maximum pressure differences. However, new facilities designing under each customer requirement is **inefficient**, leading to unnecessary labour and financial costs, which ultimately affects the plant cost. In addition, the customer may **not accurately determine the working point**, and purchased plant will have to adjust.

**Let's look at an example** of characteristics field using and **find standard model of the compressor plant.** For example, the production requires performance of **17 $m^3$/min**. The calculations are supposed to show that at the outlet the air blowing machine will generate pressure **68 kPa** to overcome pipelines resistance.

Denote the required working point in the field characteristics. Define color by pressure scale that corresponds to 68 kPa **(0-1).** Draw a line across the characteristics field (**1-2**). From a point on the performance axis corresponding to the required performance 17 m3/min, draw vertical line (**3-4**). Lines cross-up (**1-2**) and (**3-4**) gives the desired working **point O**. If you draw a perpendicular (**point O-5**) to the power axis, you can learn what power is required to connect to the compressor shaft (in our case, it is 30 kW).




Often among the machine produced model there is **no version with this working point**. In our case, the closest dimension range of the plants belongs to 70 kPa pressure differential. Plant working **point A** that we saw lies near required working **point O**. Apply an individual characteristic of standard plant on the field as a line (**7-8**) and mark the working **point A** on it: mark value 17.25 on the performance scale and value 70 is marked on the pressure scale .

Of course, a standard plant will not work at nominal working **point A**, because the differential pressure (68 kPa) on it differs from nominal one (70 kPa). To know the real working point, descend along individual characteristic up to cross-up with straight line (**1-2**), in **point B**.

It is obviously, that in pressure drop kPa 68 the standard plant will give slightly large performance than required for production (difference ΔQ ≈ 1 $m^3$/min) and spent a great deal of power, which is defined by the perpendicular drawing (**point B-6**) to the power axis, in our case it is 31 kW.

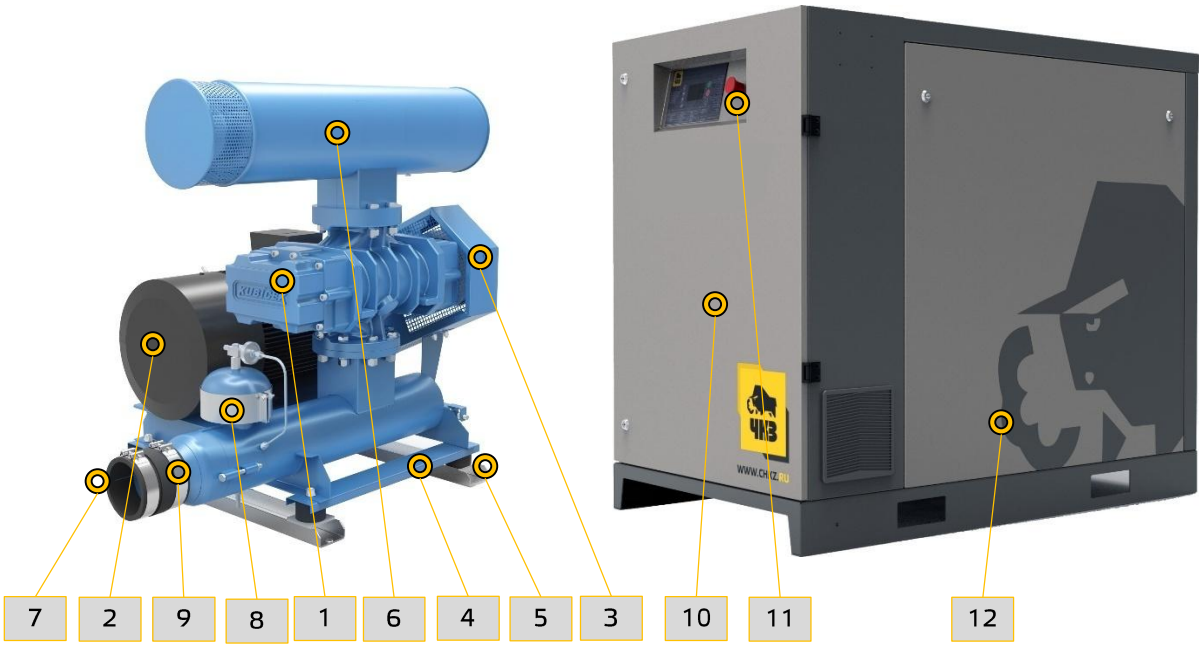
The variable frequency drive is the most effective application. With frequency decreasing, compressor capacity will fall and the working **point B** will switch to required working **point A** virtually without efficiency coefficient decrease.

**The standard plant overcapacity** can be very important if in pressure drop calculating there were inaccuracies, which cause plant requirements underrating.

# AIR BLOWING PLANTS AND STATIONS

## Plant designs

The air blowing plant with 3-teeth Ruts's positive displacement compressor UVN to gear oil-less compressor plants and consists of the compressor **1** located on common frame **4**, which is rotated by asynchronous motor **2** via a belt gearing **3**. Depending on the combination of pulleys diameters, the belt transmission works as a gear box (engine pulley is smaller than compressor one) or as multiplier (engine pulley is more than compressor one).




The plant has also mounts (pillow) **5** to prevent the compressor unit vibrations transmission. Air suction is carried out either directly from the environment through the filter-silencer **6**, or from a collector. Suction inlet is located at the top of the compressor **1**. Air injection is made through a branch pipe with compensator **7**, before which the safety valve **8** is set to protects the machine from excess pressure and return valve **9** to prevent reverse airflow when the compressor stops, as well as rotors reverse rotation. Discharge hole is at the compressor bottom.

Compressor is provided by electric control cabinet **10**, containing both power electric automation devices and microprocessor control unit **11**. In configuration without cover the electric cabinet is made as separate one, in version with cover the cabinet can be located directly in the cover **12**.

## Plant versions

**Air blowing machine**
**UVN-N**

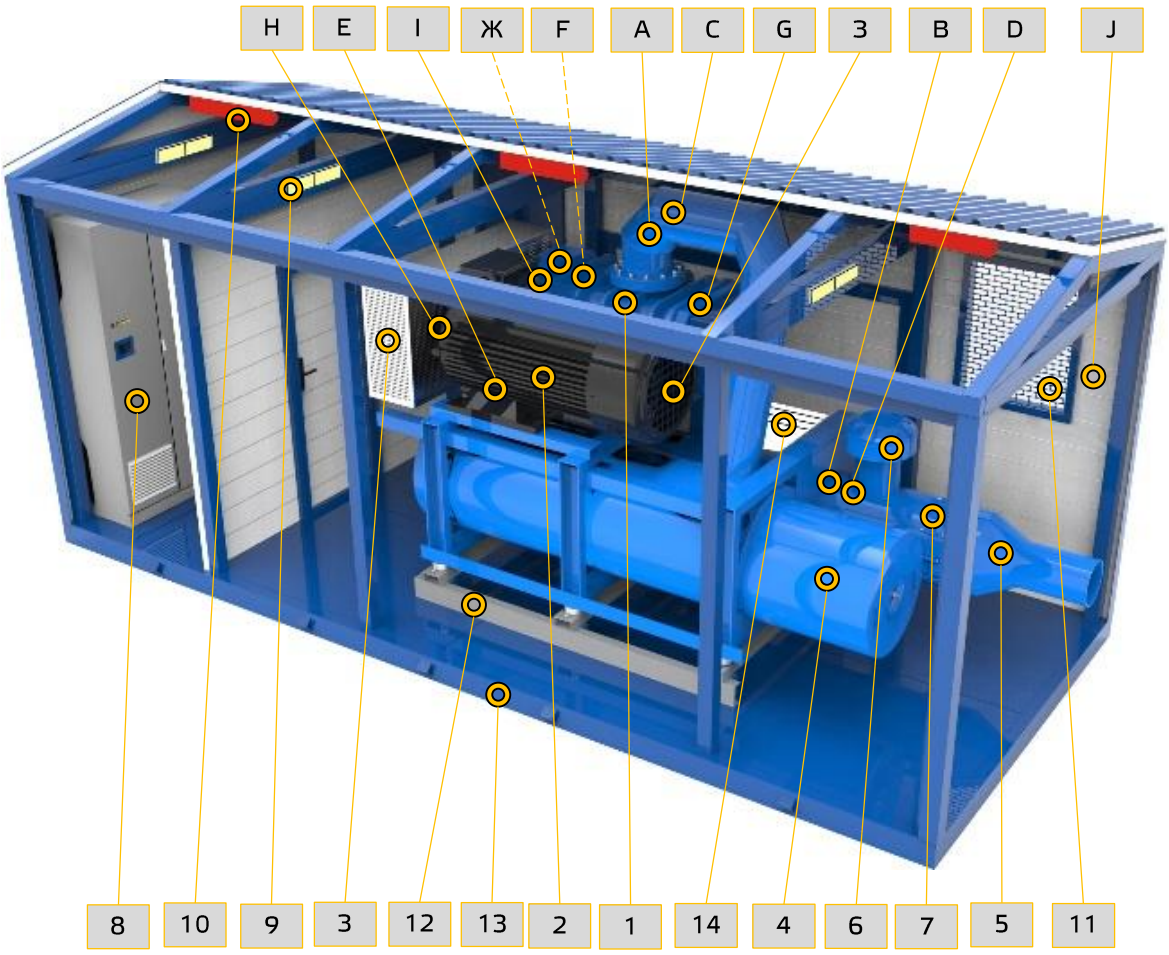
**Vacuum machines**
**UVN-V**

**Gas discharge machines**
**UVN-A, UVN-Ex**

**Air blowing machine for special machinery**
**UVN-M**

## The design of stations

Our factory has developed and successfully embeds in industrial enterprises technical solution - the **SVN** container unit air blowing station developed on the base of **UVN** air blowing plant. The machine Heart is 3-tooth positive displacement compressors. A high degree of standardization allows you to use the same compressor to get different performance by matching pulleys (ratio) and drive motors with a corresponding pressure drop.




The **SVN** standard air discharge station consists of the positive displacement compressor **1** driven by the asynchronous motor **2** via a belt gearing **3**. The compressor receives air from the intake drain **4** and sends it to the consumer along the discharge drain **5** that has safety valve **6** and return valve **7**. Assembled on a common frame **12** mentioned elements form **UVN** air discharge plant in non-covered version, which control system is integrated in main cabinet of control and power automatic equipment **8** usually located in a separate room.

All the equipment is housed in a weatherproof container block **13**, to be provided by lighting systems **9**, fire-extinguishing system 1**0**, ventilation system **11** and heating system **14**. Systems can be installed both in standard version and modified one in by the customer's request.

Plant operation monitoring and its units state is carried out by the sensors group:

**A, B** – temperature sensors of incoming and exhaust air;
**C, D** – pressure sensors on suction and discharge;
**E, F** – vibration sensors on the compressor crankcase and electric motor;
**G, H** – bearing temperature sensors of the compressor and electric motor;
**I** – the oil level sensor in the compressor crankcase;
**J** – room temperature sensor.

## Scope of use

**Aerating system**
- at the treatment plants, in tanks for fish farming, in the fractionation Systems of physically and chemically heterogeneous materials

**Gas burners**
–at the enterprises of different industries with proportional mixing of fuel gas with air before feeding into the burner

**Ventilation systems**
-to ensure ventilation of large premises, to maintain a certain climate, humidity, temperature

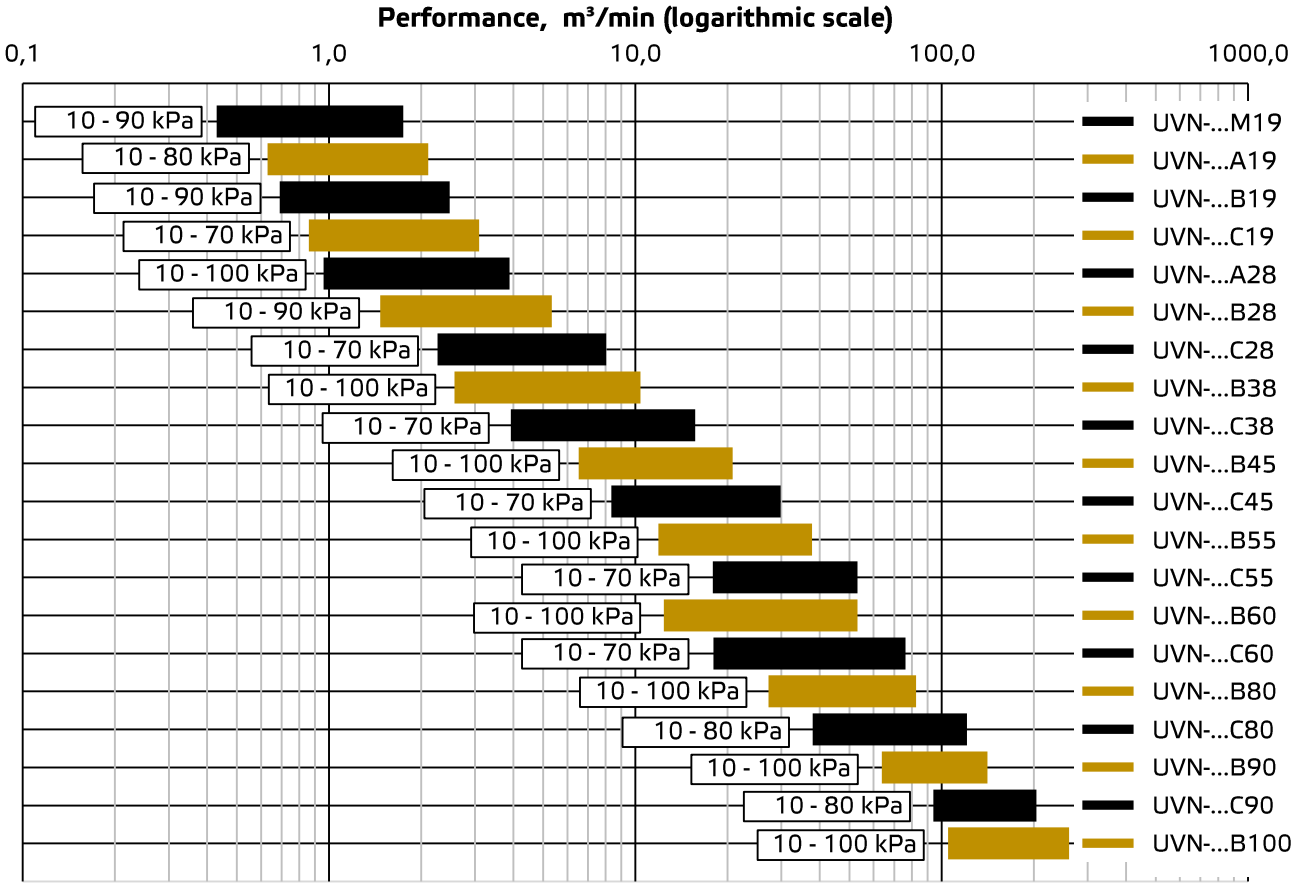
**Pneumatic transport**
-for transportation of loose materials on productions or objects (capsules, documents, money, etc.) along tube transfer systems

**Vacuum systems**
- cleaning of technological vessels and filters, centralized dust removal, vacuum packaging, sampling of hazardous gases for analysis

**Anti-icing systems**
-creating whirlpools in port waters, vessels and other reservoirs, operated at negative temperatures

## Specifications Range

The graph shows the performance ranges of the UVN compressor plants depending on the used compressor dimension size. The performance minimum value is given with maximum pressure drop, performance maximum value is given with minimum differential. Machines detailed characteristics are given in Annex A.




**Note:** the chart is constructed to conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20⁰ c, intake air density is 1.2 kg/m3.

The table shows the specifications ranges, covering standard versions of plants and stations. The plant with specific specifications can be designed at the customer's request.

| Parameter | | Measure of unit | Value range |
|---|---|---|---|
| Performance nominal, not specified | Plants | $m^3$/min | 0,4…260,0 |
| | Stations | | 6,0…1560,0 |
| Inlet nominal pressure, abs. | | MPa | 0.101 |
| Outlet nominal pressure, abs. | | | 0,111…0,201 |
| Nominal Pressure drop on the compressor | | kPa | 10…100 |
| Compressor class | | - | positive displacement |
| Compressor type | | - | 3-teeth gear (Rutsa) |
| Power | Plants | kW | 0,2…450,0 |
| | Stations | | 5,5…3200,0 |
| Number of units in the station | | - | 1…6 |
| Nominal voltage | | B | 220; 380 |
| Nominal Air temp. | inlet | °C | +15...+25 |
| | Discharge | | +40...+110 |
| Operating temperature: | plant | °C | +15…+30 |
| | station | | -40…+40 |
| Climatic category (GOST 15150-69) | plant | - | U4 |
| | station | | U1, UHL1 |
| Ex Protection | | - | no/ yes |
| medium compression principle | | - | greaseless (oilless) |
| Pumped Wednesday | | - | air/gas/natural gas |
| Mobility | | - | stationary/2-axle chassis, |
| Dimensions | Plants | mm | 700x600x610 (smallest) 2800x1400x1500 (largest) |
| | Stations | | 4500x2900x3100 (smallest) 8000x5800x3100 (largest) |
| Weight | Plants | kg | 106…7500 |
| | Stations | | 4000…32000 |

## Air filtration

To protect the pulsatory assembly against early wear the air blowing machines are equipped by particle filters on suction. Taking into account the fact that the pressure developed by machines, is small, the use of other cleaning devices (dehumidifiers, moisture and oils filters, etc.) is difficult, so the air quality almost directly depends on the quality of the intake one. Filter specifications are shown in the table, the assortment is presented in annex B.

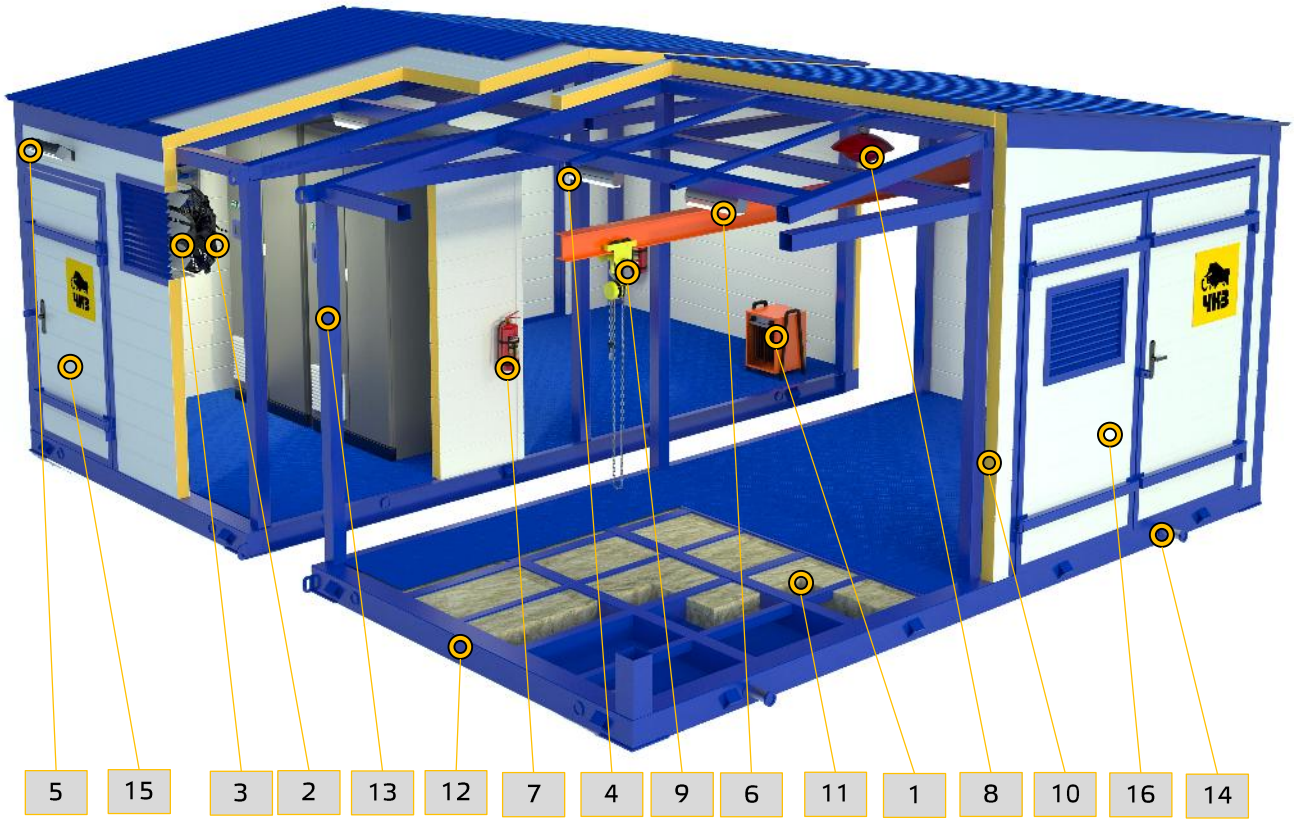
| Parameter | | Measure of unit | Value |
|---|---|---|---|
| Cleaning efficiency | 0.3…0.5 μm | % | 5 |
| | 0.5…1.0 μm | | 10 |
| | 1.0…5.0 μm | | 35 |
| | more than 5.0 μm | | 95 |
| Material of the filter element | | - | non-woven polyester |
| Class cleaning from mechanical impurities | GOST 8573-1:-2010. | - | 5…6 |
| | EN 779 | | G3 |
| Nominal Flow rate | | m/s | 1.2…1.4 |
| filter pressure Loss | | Pa | 90…120 |
| air flow temperature | | °C | -50…+150 |

## Container unit design

The station is placed in warmed container unit, that represents a welded metal frame with floor of metal fluted sheet, sandwich panel walls and a metal pitched roof. Depending on the project, the container has a different length (up to 12 m) and can be combined with other containers by technological hinge joint and bolts. Large stations are assembled from several containers in a single building and located as stand-alone modules.

BBS construction has the following features:

- significantly lower cost compared to the capital building;
- to transport station of almost any size from the factory to the operation place with the parts by standard vehicles and public roads;
- container inner equipment is installed at the plant, at operation site it only is connected to the communication systems;
- the station can be easily modified by the standard containers.




In winter station Heating is carried out by the fan heater **1**, in summer ventilation is carried out by fan **2** with automatic shutter **3** that can be opened and closed at a certain angle.

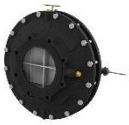
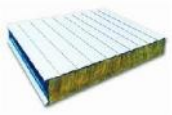
Interior lighting is provided by led lamps **4**, external one is carried by lamp **5**. Emergency lighting lamps **6** is provided.

The station is provided with hand-held extinguishers **7**. Powder fire extinguishing system **8** is provided as standard.

The station design has hand-chain hoist **9** to move heavy components and devices. The station walls are made of insulated wall panels **10**, floor is warmed by plates **11**. The station is located on the base frame **12**, walls and cover are an arched construction **13**. To move containers, Slinging ear bolts **14** are provided in station base plate.

The station has entrance door **15** and cargo gate **16**. Their location and number is determined by the size of the station and the principles of accommodation equipment.

# Additional equipment

| Option | | Description |
|---|---|---|
|  | **Tubular Heat exchanger** | Carries out heat removal of discharge or charge air depending on the installation site, by coolant. |
|  | **Silencer** | Suppresses resonance produced by air (gas) sound and is mounted directly in the pipeline, including an absorbent material. |
|  | **High capacity fuse** | Prevents flame transferring and propagation under subsonic speeds, inhibiting flame propagation on both sides, separates the air drain elements from the environment. |
|  | **Air changes per hour system** | Allows to carry out ventilation in the station premises in multiples of certain value. Is applied in case of special requirements for air exchange rate of the operating organization. |
|  | **Environment control system** | Maintains the desired temperature in the station premises regard-less of the ambient temperature, as a rule, it is aimed at forced cooling. |
|  | **Security and fire alarm system** | Provides station monitoring. In case of smoke, fire or unauthorized entry into the premises it shall inform the station personnel by alarm signal and message on the control panel. |
|  | **Gaseous Extinguishing System** | Carries out gaseous fire suppression and is set as an alternative of foam extinguishing system "Buran" by customer's request or by special fire extinguishing system requirements. |
|  | **Electric Convector Heating system** | Provides station premises heating and is used as an alternative of heat fans. It is located on the station walls of the and takes small space. |
|  | **Diesel generator** | Provides emergency power generation for station in faults or shutdown od main feed power. It is started automatically. |
|  | **Wall panels with mineral wool insulation** | Provide lower coefficient of thermal conductivity, make climate of station premises more independent from ambient temperature fluctuations. |
|  | **Detachable cover** | Allows to mount and demount machinery and equipment by hoists with removed cover, eliminating need of their more difficult moving inside the container. |
|  | **Anti-slip flooring** | Exclude sliding during moving through the station even in case of icing or liquids spilling. |
|  | **Tool kit** | Includes all the necessary tools for the maintenance and repair of machines and equipment of the station. |
|  | **Branding** | Colouring station in Enterprise brand color, logos, marks and other symbols. |

# TECHNICAL SOLUTIONS IN PHOTOS

## Gas transmission systems

55 kW, DN =150 mm

75 kW, 150 mm DN =150 mm

1.5 kW DN = 32 mm

75 kW, DN =150 mm

1.5 kW DN = 32 mm

75 kW, DN =150 mm

110kW, 150 mm DN =250 mm

## Gas transport stations

30 kW, DN =150 mm


5.5 kW DN= 100 mm


SVN for Syzran oil refinery

75 kW, DN =150 mm

90 kW, DN =100 mm

## Mobile gas station

75 kW

15 k W

75 kW

# LEGEND EXPLANATION

### SVN-2N. 50.144.60SB100.3

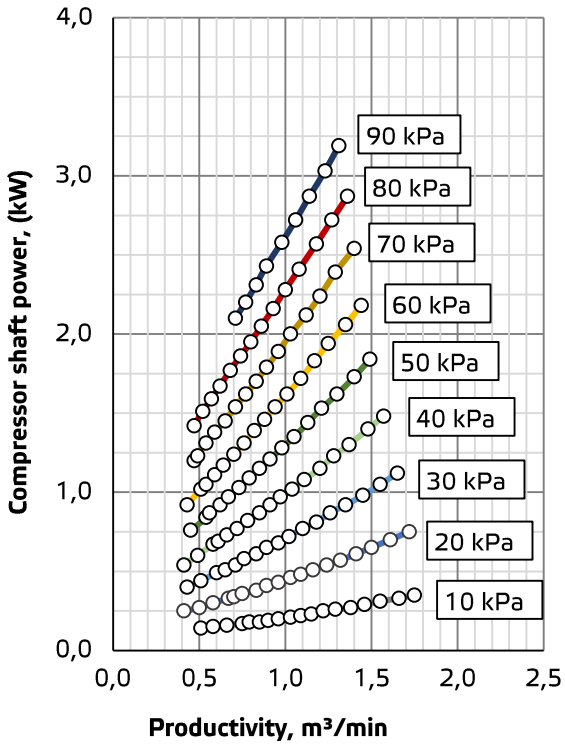
**SVN** – machines index mark (**SVN** – air discharge station, **UVN** – air discharge plant);
**2** – number of air discharge units (1 – 6);
**N** – version (**H** – general-duty type; **V** – vacuum; **G** - gas general one; **Ex** – gas explosion-proof; **M** - for use in specialized vehicles);
**50** – blower differential pressure, kPa;
**144** – machine performance, $m^3$/min;
**60** – plant or station power is maximum with all working machines and devices (without standby equipment) kW;
**S** – compressor noise absorbing caver (**S** – with cover; **O** – without cover for location in container unit);
**B** – enclosure type of air blowing compressor (**M** – the smallest, **A** – small, **B** – average, **C** – large);
100 – compressor drive shaft diameter, mm;
3 – station automation degree (**0** – without control system; **1** – minimum; **2** – small; **3** – medium; **4** – maximum).

# ANNEXES

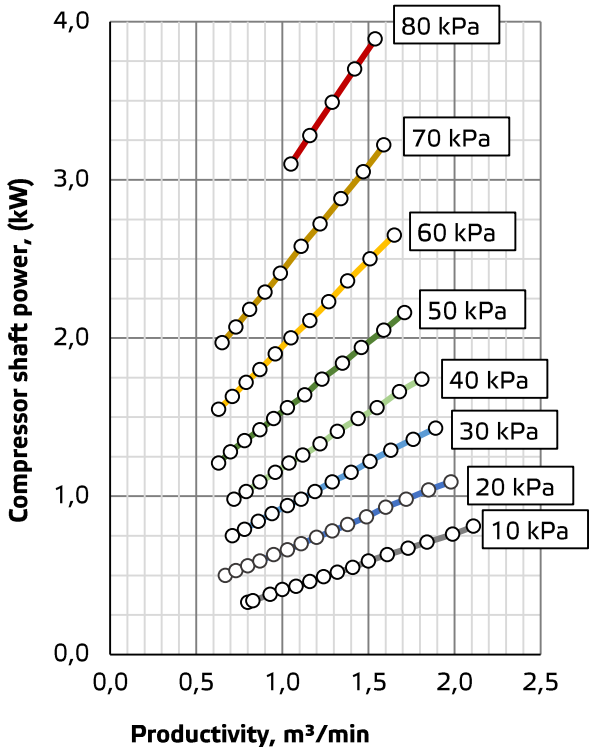
## ANNEX A. UVN specifications

### A1. Small machines with shaft diameter 19...38 mm

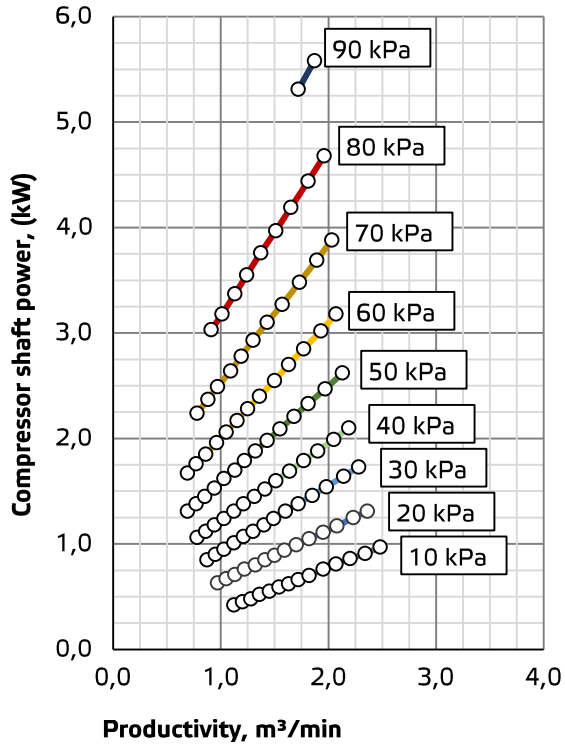
**UVN -...M19**



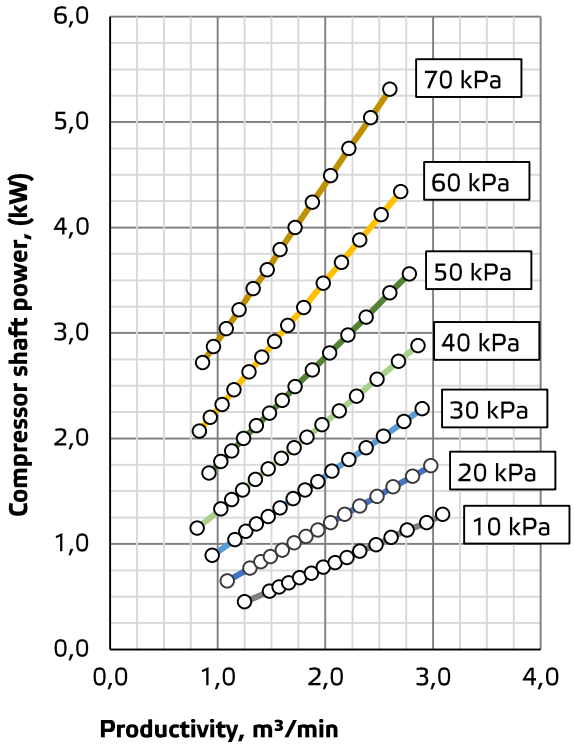

**UVN-...A19**



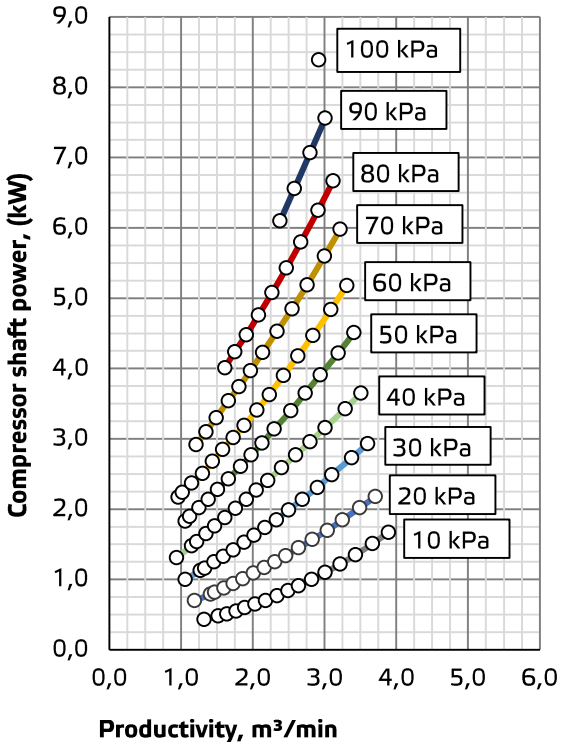

**UVN-...B19**



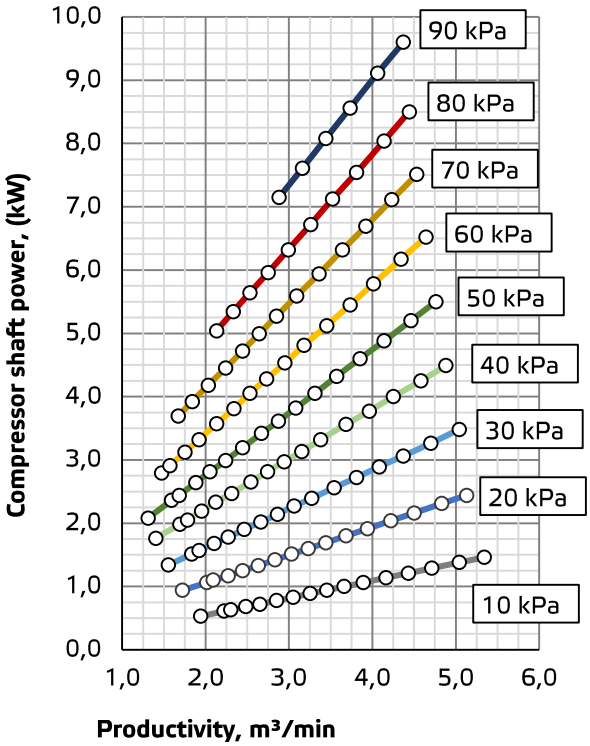

**UVN-...C19**



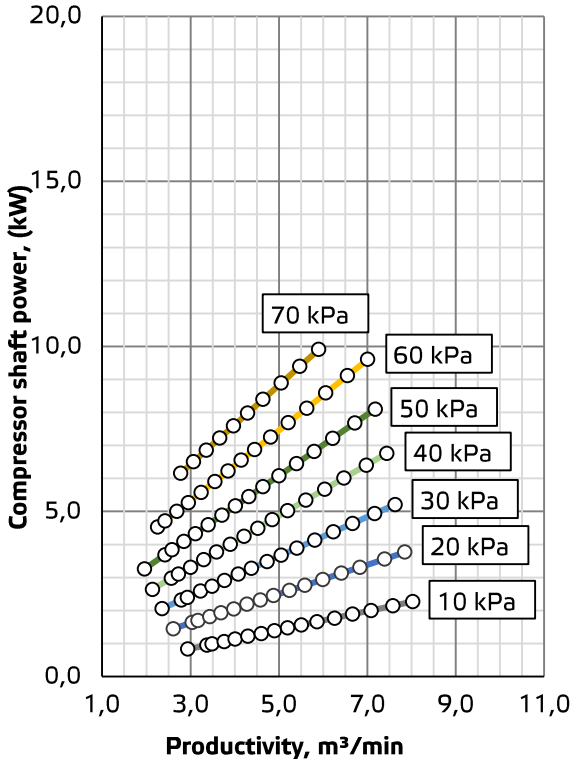
### UVN-...A28



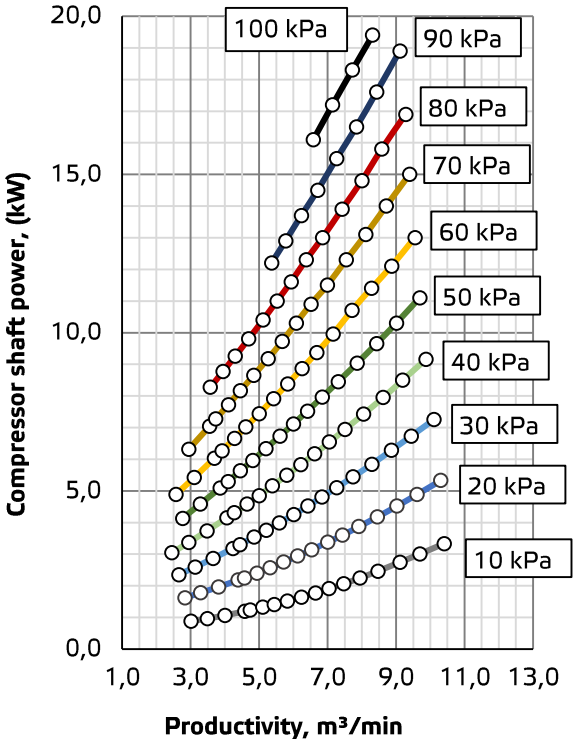

### UVN-...B28




### UVN-...C28

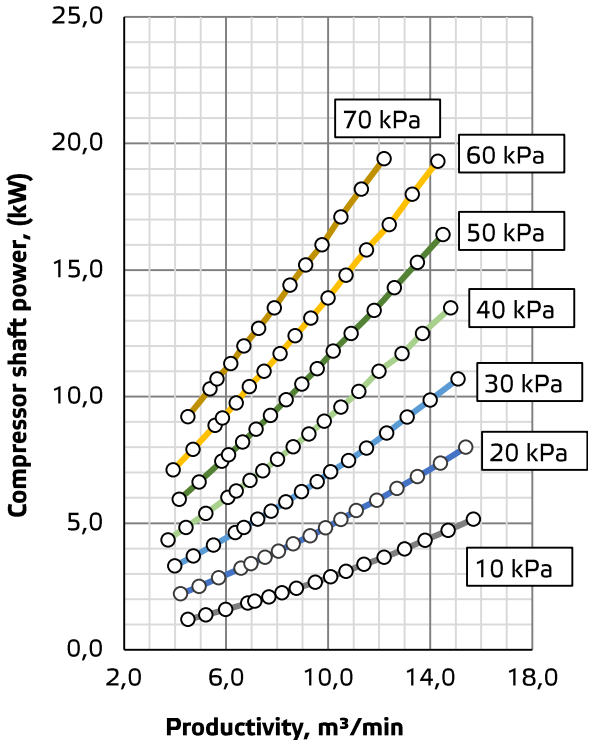



### UVN-...B38



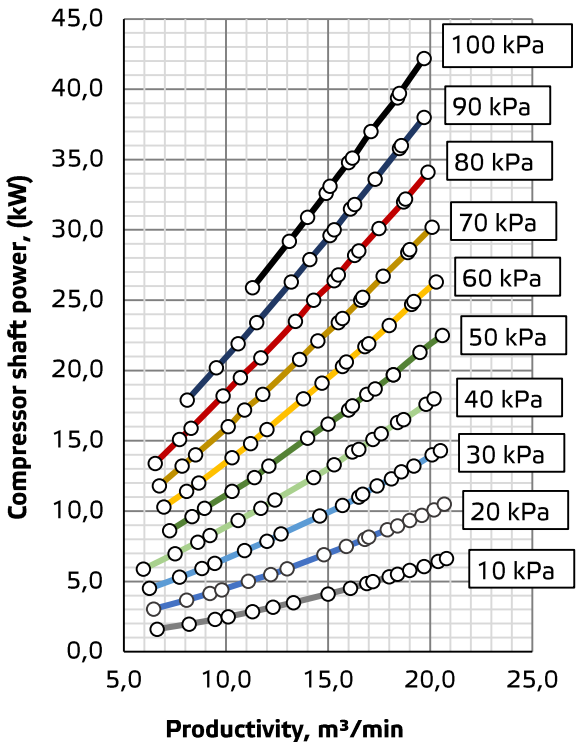

**Attention!** Parameters are given for the following conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20 °C, intake air density is 1.2 kg/m³. Points on the constant pressure curves correspond to the nominal values of the standard dimension sizes, other specifications is on request.

### UVN-C38

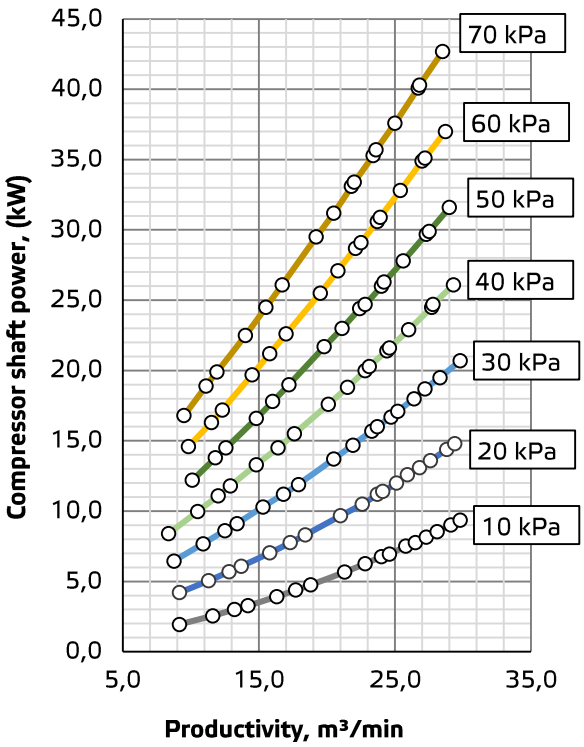



## A2. Medium machines with shaft diameter 45...60 mm

### UVN-...B45

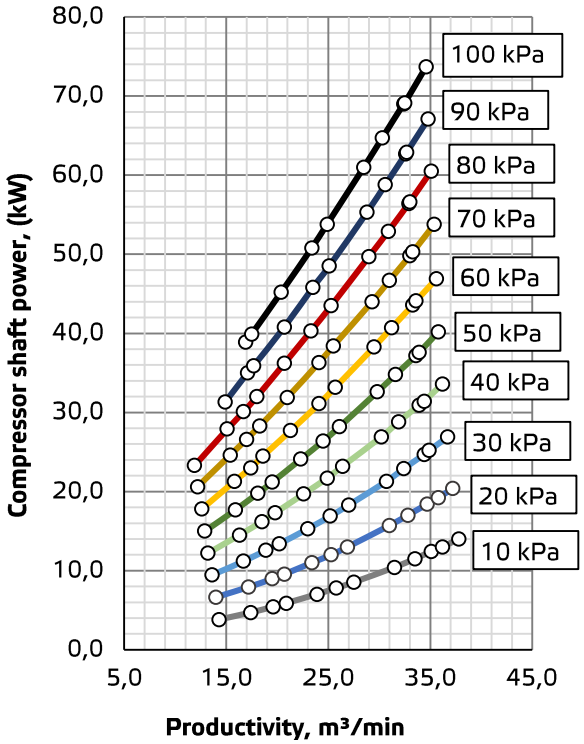



### UVN-...C45

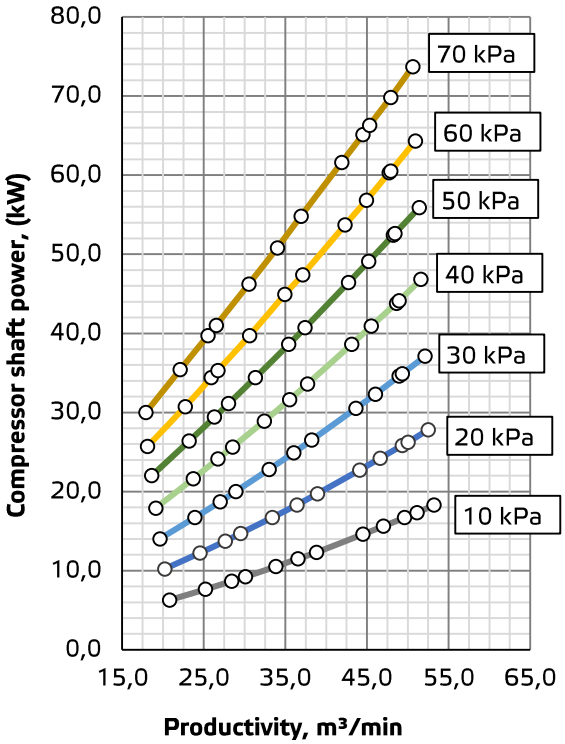



**Attention!** Parameters are given for the following conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20 ºC, intake air density is 1.2 kg/m$^3$. Points on the constant pressure curves correspond to the nominal values of the standard dimension sizes, other specifications is on request.

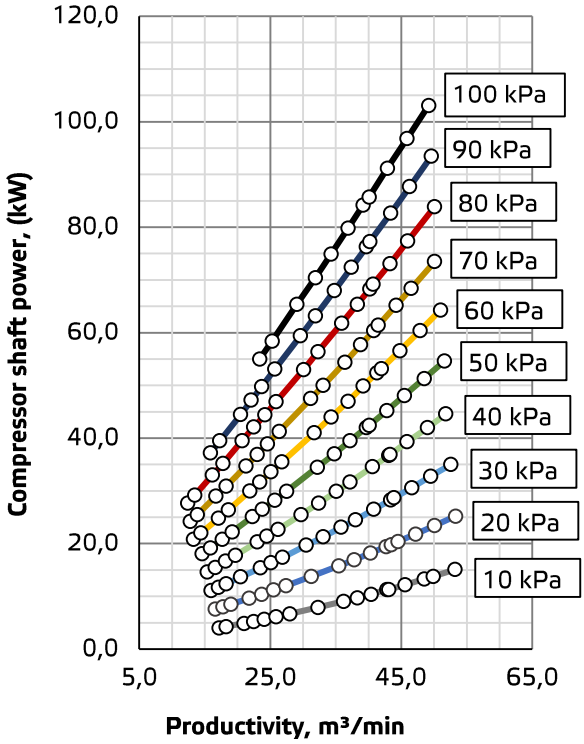
## UVN-...B55



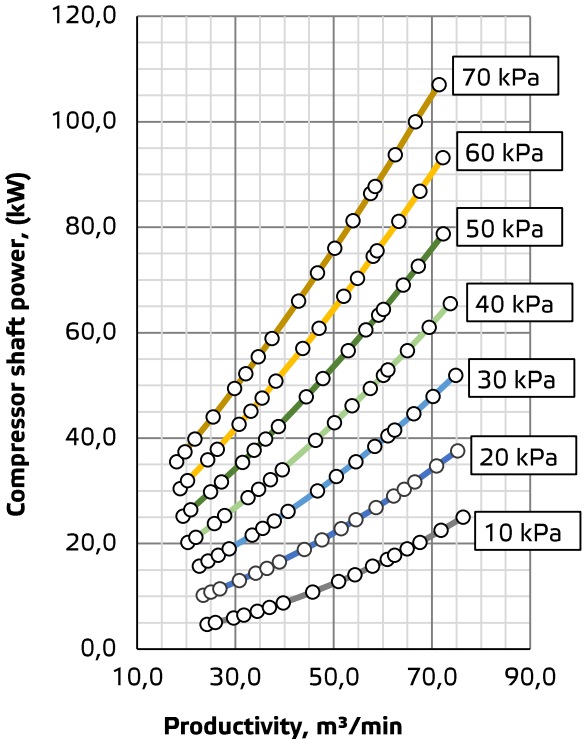

## UVN-...C55




## UVN-...B60



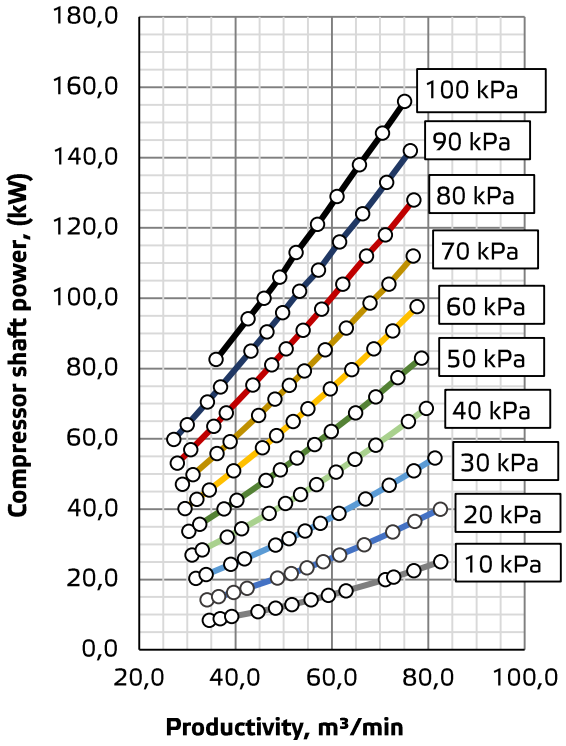

## UVN-...C60



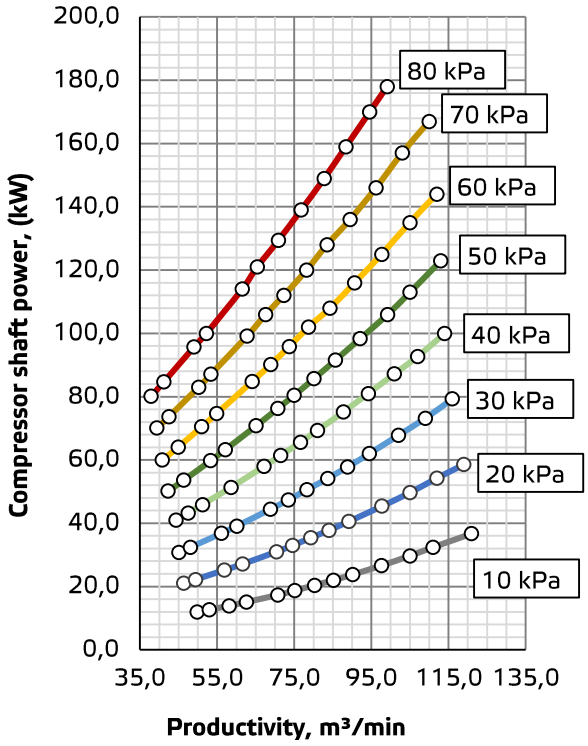

**Attention!** Parameters are given for the following conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20 ºC, intake air density is 1.2 kg/m3. Points on the constant pressure curves correspond to the nominal values of the standard dimension sizes, other specifications is on request.

## A3. Large machines with shaft diameter 80...100 mm

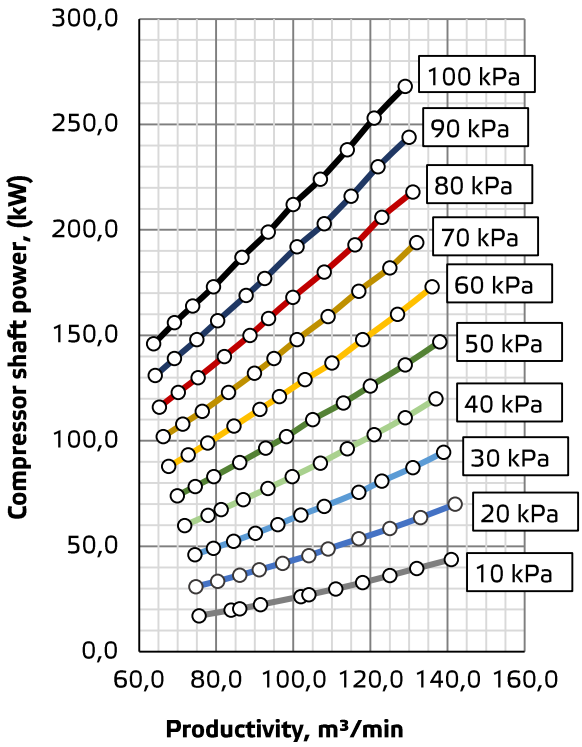
### UVN-...B80



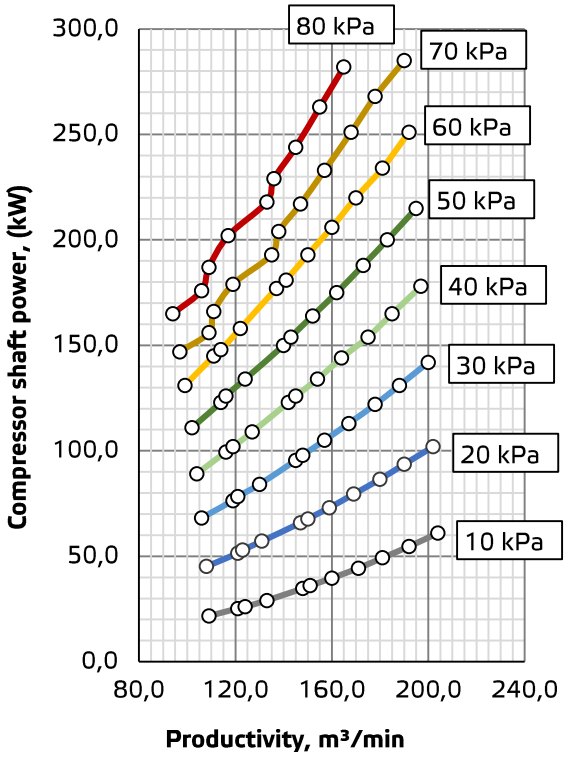

### UVN-...C80



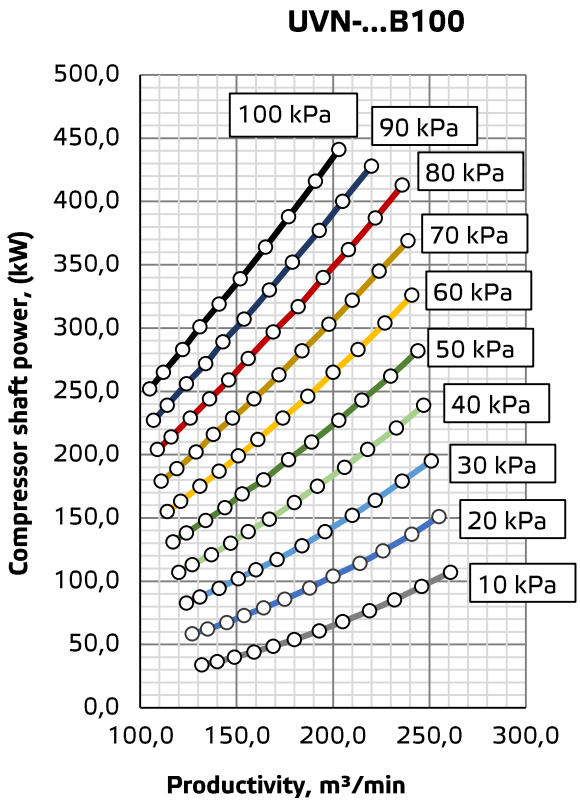

### UVN-...B90




### UVN-...C90




**Attention!** Parameters are given for the following conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20 ºC, intake air density is 1.2 kg/m³. Points on the constant pressure curves correspond to the nominal values of the standard dimension sizes, other specifications is on request.




**Attention!** Parameters are given for the following conditions: absolute inlet pressure is 101 kPa (atmospheric), intake air temperature is 20 ºC, intake air density is 1.2 kg/m3. Points on the constant pressure curves correspond to the nominal values of the standard dimension sizes, other specifications is on request.

## ANNEX B. Particle Filters

| Plant | DN, mm | Dimensions of filter element, mm (ø - diameter) | Dimensions of frame, mm (ø - diameter) | Filter element location at frame | Filter fineness, um |
|---|---|---|---|---|---|
| UVN-...19 | 50 | 238x200 | 236x95 | external | 5.0 |
| UVN-...28 | 80 | 262x270 | 260x130 | | |
| UVN-...38 | 100 | 172x580 | 175x476 | Internal | |
| UVN-...45 | 150 | 257x1100 | 260x960 | | |
| UVN-...55 | 150 | | | | |
| UVN-...55 | 200 | 323x1500 | 326x1290 | | |
| UVN-...60 | 200 | | | | |
| UVN-...60 | 250 | 407x1100 | 410x950 | | |
| UVN-...80 | 250 | | | | |
| UVN-...80 | 300 | 491x1800 | 493x1590 | | |
| UVN-...90 | 300 | | | | |
| UVN-...90 | 400 | 628x2200 | 630x1950 | | |
| UVN-...100 | 400 | | | | |

# ANNEX C. GOST-8573-1-2010

## C1. Solids contamination class

| Class | Maximum number of particles in 1 m³ Particle size d, (μm) | | | | Solids Dimension, μm | Concentration, mg/m³ |
|---|---|---|---|---|---|---|
| | $\leq 0,10$ | $0,10 < d \leq 0,5$ | $0,5 < d \leq 1,0$ | $1,0 < d \leq 5,0$ | | |
| 0 | According to the customer's or supplier's requirements, but it is more stringent than for class 1 | | | | Not set | Not set |
| 1 | Not set | 100 | 1 | 0 | | |
| 2 | Not set | 100000 | 1000 | 10 | | |
| 3 | Not set | Not set | 10000 | 500 | | |
| 4 | Not set | Not set | Not set | 1000 | | |
| 5 | Not set | Not set | Not set | 20000 | | |
| 6 | N.A. | | | | $\leq 5,0$ | $\leq 5,0$ |
| 7 | N.A. | | | | $\leq 40,0$ | $\leq 10,0$ |

## C2. Water and humidity contamination class in the liquid phase

| Class | Dew point temperature,° C | Water concentration in the liquid phase C, g/m³ |
|---|---|---|
| 0 | According to the customer's or supplier's requirements, but it is more stringent than for class 1 | |
| 1 | $\leq -70$ | Not set |
| 2 | $\leq -40$ | Not set |
| 3 | $\leq -20$ | Not set |
| 4 | $\leq +3$ | Not set |
| 5 | $\leq +7$ | Not set |
| 6 | $\leq +10$ | Not set |
| 7 | Not set | $\leq 0,5$ |
| 8 | Not set | $0,5 < C \leq 5,0$ |
| 9 | Not set | $5,0 < C \leq 10,0$ |

## C3. Oil concentration contamination class

| Class | Oil total concentration (in aerosol, liquids and vapor phases) , mg/m³ |
|---|---|
| 0 | According to the customer's or supplier's requirements, but it is more stringent than for class 1 |
| 1 | $\leq 0,01$ |
| 2 | $\leq 0,10$ |
| 3 | $\leq 1,0$ |
| 4 | $\leq 5,0$ |

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