Steam jet vacuum pumps

Steam jet pumps are particularly appropriate as vacuum pumps, as they can easily handle large vacuum volumes.
Single stage jet pumps, which convey against atmospheric pressure are used for the production of vacuum down to a suction pressure of approx. 100 mbar.
For lower suction pressures multi-stage steam jet vacuum pumps are used, with or without intermediate condensation. For more details, please refer to section "Vacuum systems", ↗ | gdp 1.

ADVANTAGES

- no moving parts
- easy handling of even very large suction flows
- low maintenance cost
- long life
- high reliability and safety of operation
- low priced, low operating cost
- manufacture from various materials of construction

DESIGN

Steam jet vacuum pumps have a tailor-made design depending on the individual requirements. In this way optimum efficiency is achieved.

PERFORMANCE CHART FOR VACUUM PUMPS

EXAMPLE

It is required to extract $\dot{M}_0 = 50$ kg/h of air at 20 °C from a suction pressure of $p_0 = 200$ mbar. A motive steam pressure of $p_1 = 10$ bar g is available.
From the diagrams **fig. 1** and **fig. 2**, the required motive steam flow as well as the suction connection diameter can be ascertained in relation to the suction pressure and suction flow.
The overall dimensions of the equipment are fixed in relation to the suction connection diameter.

Fig. 1 shows a specific steam consumption of

$$\mu = 3 \frac{\text{kg Steam}}{\text{kg Air}}$$

The steam consumption is, therefore,

$$\dot{M}_1 = \mu \cdot \dot{M}_0 = 3 \cdot 50 = 150 \frac{\text{kg}}{\text{h}}$$

In **fig. 2** the operating point
suction flow = 50 g/h and
suction pressure = 200 mbar
is between the curves for DN 40 and DN 50.

Steam jet vacuum pump in metal

Steam jet vacuum pump in porcelain

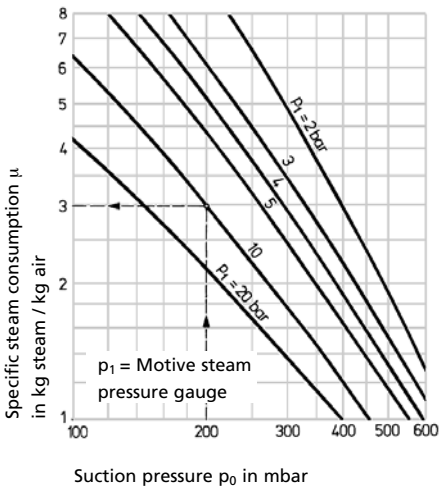
DN 50 is chosen as the curves in **fig. 2** give the maximum possible suction flow for each particular size. The dimensions of the required jet pump, in various materials of construction, are given in **fig. 9 and 10**.

The diagrams **fig. 1 and 2** are valid for a suction medium of air at 20 °C. At other suction temperatures, but at the same suction pressure, the suction flow is calculated according to the following equation:

$$\dot{M}_{0_t} \approx \dot{M}_{0_{20}} \cdot \sqrt[4]{\frac{293}{273 + \vartheta}}$$

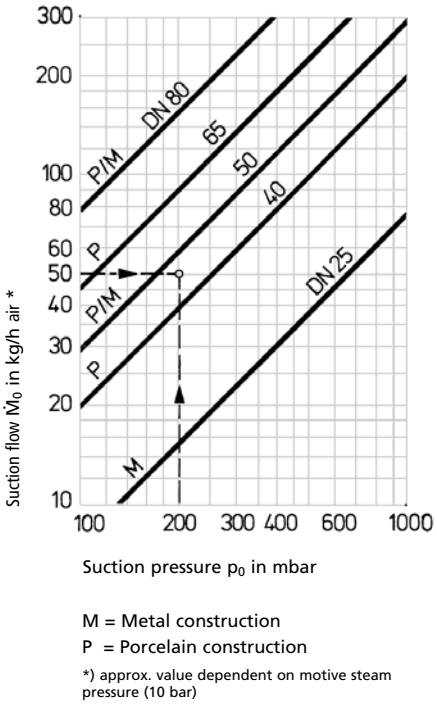
If water vapour, instead of air, is to be drawn off, the suction flow is approx. 80 % of the values given in diagram **fig. 2**. For other gases or vapours see section "Equivalent suction flows for steam jet vacuum pumps", ↗ | abl 12.

FIG. 1



Specific steam consumption of a single stage steam jet vacuum pump when compressing to atmosphere (1013 mbar)

FIG. 2



Maximum possible suction flow in kg/h for air at 20 °C

PRE-EVACUATION

If a plant is to be evacuated within a given time, for example, during start-up, and the vacuum pump which maintains the operational vacuum takes longer than the given time, a jet pump is added to speed up the evacuation. This jet pump is called pre-evacuator or start-up jet pump.

This pump is brought into operation together with the vacuum pump, but works only until the required vacuum, or a determined intermediate vacuum is reached (see also section "Vacuum systems, Planning of a steam jet vacuum pump", ↗ | gdp3).

In order to determine whether a pre-evacuator is required, the evacuation time of the vacuum pump has to be calculated with the help of the following formulas:

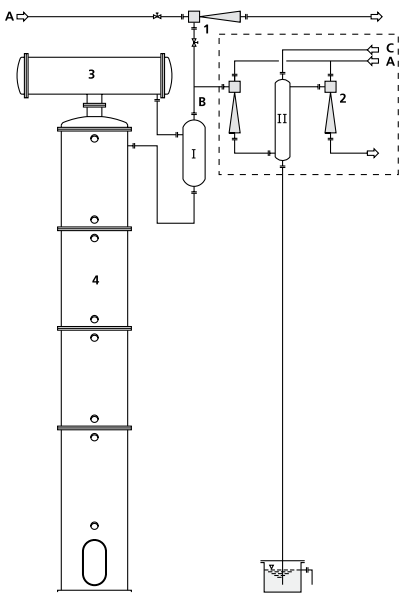
$$t_{evac.\,DVP} \approx \frac{V \cdot (1000 - p_0) \cdot 60}{840 \cdot \dot{M}_A \cdot 3} \approx \frac{V \cdot (1000 - p_0)}{\dot{M}_A \cdot 42}$$

in minutes.

Where:

V	Volume of the plant to be evacuated in m³
p_0	Required operating vacuum (suction pressure) in mbar
$\dot{M}_A$	Air suction flow in kg/h, for which the steam jet vacuum pump is designed

FIG. 3



1 Steam jet vacuum pump as pre-evacuator
2 Two-stage steam jet vacuum pump
3 Column head
4 Column
I Separator
II Mixing condenser
A Motive steam
B Suction flow
C Cooling water

Pre-evacuation of a vacuum plant

From the result obtained, it can be estimated whether a pre-evacuator is required.
Single-stage start-up jet pumps can, according to the motive steam pressure, achieve a final pressure of approx. 80 mbar.
For lower pressures a two-stage start-up jet pump must be used.

PERFORMANCE CHART FOR PRE-EVACUATORS

EXAMPLE

A vessel with a volume of 31 m³ is to be evacuated from 1000 mbar to 80 mbar in 15 minutes. Motive steam at 10 bar g is available.
From **fig. 4** for 80 mbar and 10 bar g one finds a specific motive steam consumption of 2.28 kg motive steam/m³ volume to be evacuated.
The steam consumption is then calculated with the aid of the following formula:

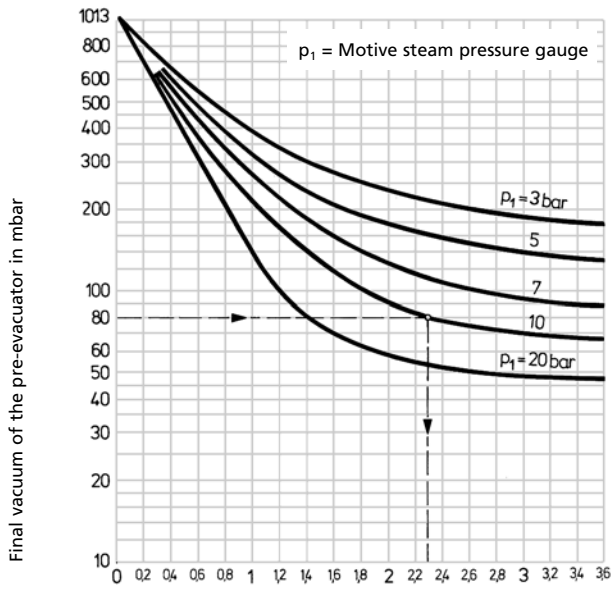
$$\dot{M}_D = D_{spec.} \cdot V \cdot \frac{60}{t}$$

$\dot{M}_D$	Steam consumption in kg/h
$D_{spec.}$	kg motive steam/m³ volume to be evacuated
V	Volume of the plant to be evacuated in m³
t	Required evacuation time in minutes

$$\dot{M}_D = 2.28 \cdot 31 \cdot \frac{60}{15} = 283\ \frac{kg}{h}$$

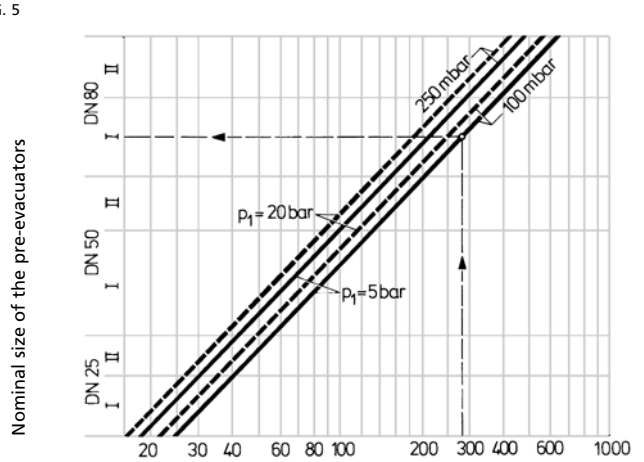
Fig. 5 gives the nominal diameter of the pre-evacuator required for this steam consumption. The example given requires a pre-evacuator DN 80 I.

FIG. 4



Spec. steam consumption $D_{spec.}$ in kg motive steam/m³ of plant volume to be evacuated

FIG. 5



Motive steam consumption in kg/h

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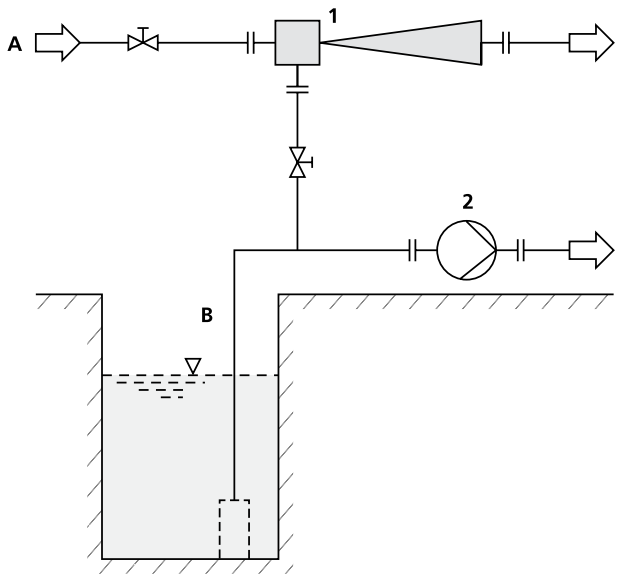
FIG. 6

EVACUATION OF A SUCTION LINE

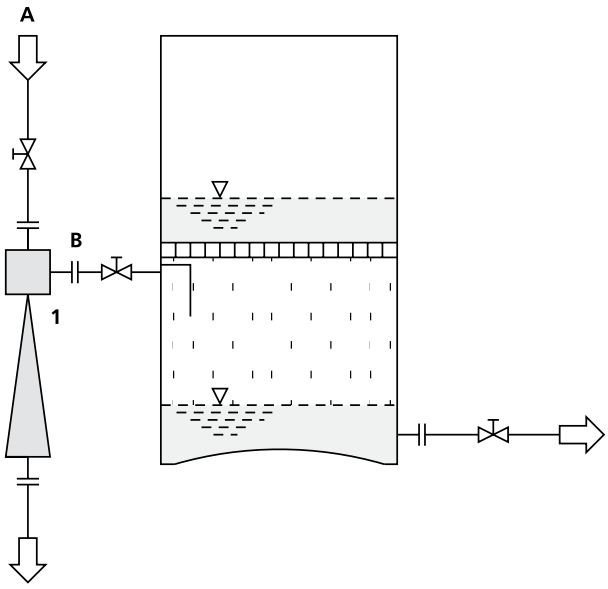


Steam jet vacuum pump for evacuating the suction line of a non self-priming pump

1 Steam jet vacuum pump
2 Centrifugal pump
A Motive steam
B Suction line

FIG. 7

VACUUM PRODUCTION



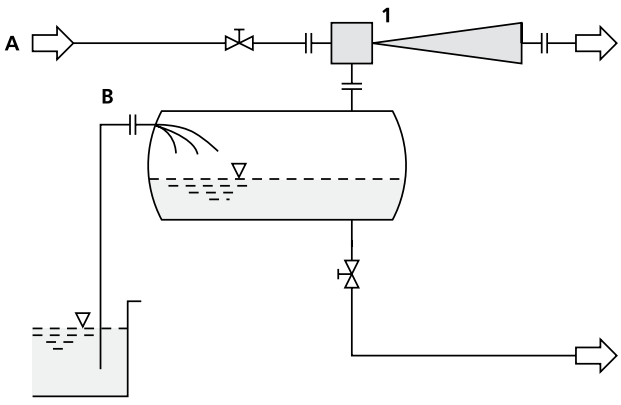
Steam jet vacuum pump for producing a negative pressure in a nutsch filter

1 Steam jet vacuum pump
A Motive steam
B Suction line

FIG. 8

LIFTING OF LIQUIDS

As long as the steam jet pump operates, vacuum is produced and liquid is drawn into the tank. When the steam valve is closed, atmospheric air returns to the tank, the vacuum is broken and lifting stops.

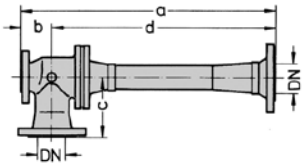


Steam jet vacuum pumps for the lifting of liquids

1 Steam jet vacuum pump
A Motive steam
B Suction line

FIG. 9

STEAM JET VACUUM PUMPS, METAL CONSTRUCTION



CONNECTIONS, DIMENSIONS AND WEIGHTS

	DN	25	25	50	50	80	80
		I	II	I	II	I	II
Steam connection DN		25	25	25	25	40	40
Dimensions in mm	a	210	300	440	550	750	930
	b	30	30	50	50	90	90
	c	100	100	110	110	175	175
	d	180	270	390	500	660	840
Weight in kg		5	7	10	15	32	38

REALIZED JET PUMP

Steam jet vacuum pump in stainless steel

STANDARD CONSTRUCTIONS:

I Housing: cast iron EN-GJL-400-15 (GGG40), motive nozzle: stainless steel
II Housing: cast stainless steel (1.4581), motive nozzle: stainless steel
DN 25 und 50: housing and diffusor screwed
DN 80: housing and diffusor flanged, diffusor welded
Flanges according to DIN PN 10 or ASME 150 lbs

If necessary the steam jet vacuum pumps can also be manufactured in other sizes, constructions and materials and flanges of other nominal pressures and standards can be supplied. This, however, does not apply to pumps of porcelain.

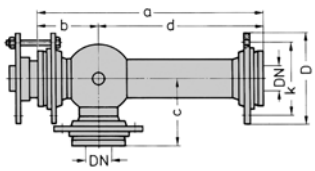
The exact installation dimensions of the pumps depend on the operating conditions. For jet pumps according to the design given in **fig. 9**, two different dimensions for each size are given.
For large nominal diameters jet pumps are designed in welded construction. The dimensions are adapted to the particular conditions.
The dimensions are given in the quotation on request (see also "Steam jet compressors", ↗ | bv 1)

SPECIAL CONSTRUCTIONS and larger nominal bores on request.
Dimensions, connection dimensions and special performance data on request.

For inquiries please use our questionnaire.

FIG. 10

STEAM JET VACUUM PUMPS, PORCELAIN CONSTRUCTION



CONNECTIONS, DIMENSIONS AND WEIGHTS

	DN	32	40	50	65	80	100	125
Dimensions in mm	a	320	405	510	653	810	1035	1270
	b	90	100	100	130	145	160	170
	c	95	110	110	120	135	150	175
	d	230	305	410	523	665	875	1100
	k	95	120	140	160	185	210	235
	D	120	150	170	185	215	240	265
Weight in kg		4	5	7	10	15	22	30

STANDARD CONSTRUCTION:

Housing and motive nozzle: temperature-change resistant porcelain
Connection clamps: aluminium cast
Steam connections: aluminium cast

The motive nozzle connections are not given in the above overview as they depend on the operating conditions.

SPECIAL CONSTRUCTIONS with different connections, nominal pressure stages of the flanges and materials on request.

If needed, the heads of steam jet compressors are provided with hand hole covers for easier cleaning.
Large nominal bores on request.

For inquiries please use our questionnaire.

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