Efficient air saving with a vacuum generator

Vacuum costs money

A vacuum generator needs to be fed with compressed air.
Since it takes energy to produce this, vacuum generation also results in energy costs.
It is therefore advisable to make vacuum generation as efficient as possible.
Reason:

Continuous vacuum generation
High energy consumption
High costs

Potential for savings with vacuum generation

It is not possible to save air while vacuum is being built up, since maximum energy is required for this (see Fig. 1, gray area).

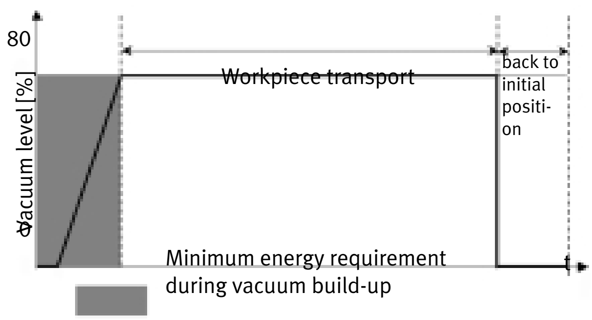


Fig. 1: Transport cycle

During workpiece transport, there is potential for saving air by switching off the generator, provided that vacuum is maintained.

To do this requires 2 additional components:

1. A non-return valve which maintains the vacuum when the generation process is interrupted
2. A pressure sensor for continuous pressure monitoring in order to obtain a indication of the instantaneous vacuum level

A. Vacuum generators without energy-saving function

A standard vacuum generator (see Fig.. 2) produces continuous vacuum during the transport operation.
This system fulfills none or only one of the criteria required in order to achieve energy saving.

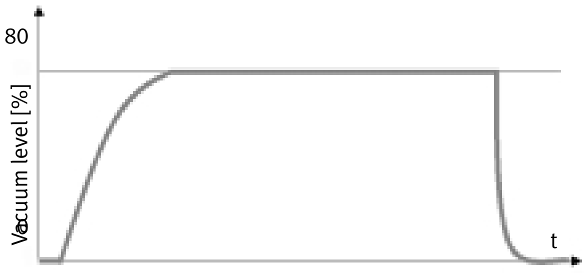
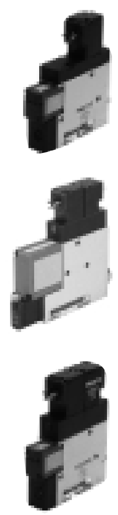


Fig.. 2: VADMI

This group includes the following models:



VADM-...
- Continuous vacuum generation without pressure monitoring

VADM-...-P
- Continuous vacuum generation with pressure monitoring

VADMI-...
- Continuous vacuum generation without pressure monitoring
  In case of malfunctions: Vacuum is maintained by non-return valve

Advantages
- Cheaper to buy
- Low weight
- PLC only for vacuum ON/OFF (simple and inexpensive control system)

Limitations
- Higher energy consumption through continuous vacuum generation
- Higher operating costs
- More complex wiring (2 cables)

B. Vacuum generator for externally-controlled energy-saving function: VADMI-...-P/N

Here, a pressure sensor has been added to the VADMI. This allows the PLC to activate the generator only until an adjustable maximum level is reached. A non-return valve then prevents loss of vacuum. The generator is activated again only when an adjustable minimum level is reached.

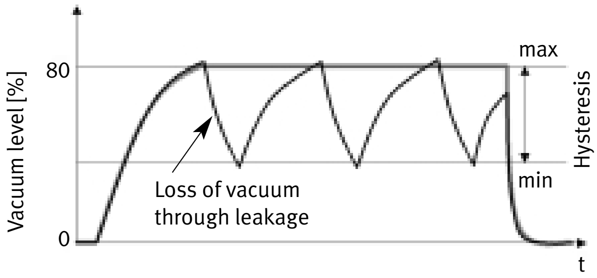


Fig. 3: VADMI-...-P/N

Air and energy are consumed only during active evacuation periods (vacuum build-up).

Advantages

- Pressure sensor
- generator is activated only when it is actually required
- Vacuum circuit gives low energy consumption
- Low operating costs

Limitations

- No alarm in cases of malfunctions
- More complex wiring (3 cables)
- PLC is required to control the energy-saving cycle (complex control system)

C. Vacuum generator with internally-controlled energy-saving function and alarm: VADMI-...-P/N-LS

This combines the vacuum circuit with an alarm function. This is located inside the sensor. If a piece of tubing bursts or contact is lost between the workpiece and the suction cup, the pressure sensor signals this to the external PLC as an alarm.

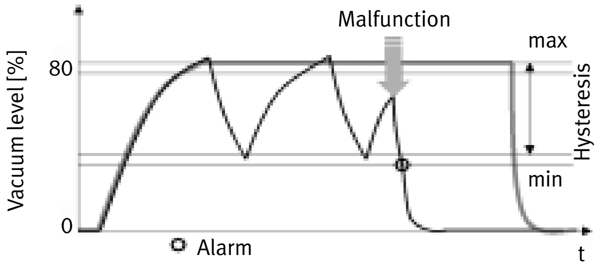


Fig. 4: VADMI-...-P/N-LS

Advantages

- Low energy consumption thanks to vacuum circuit
- Low operating costs
- High degree of operational reliability (alarm function)
- PLC only for vacuum ON/OFF (inexpensive)
- Vacuum circuit produced with pressure sensor
- Only one cable to PLC

Limitations

- High purchase cost

When is it worthwhile to use vacuum circuits?

It costs approx. 0.02 Euros to compress 1 m^3 of air to 7 bar. The degree of air saving depends on the transport cycle.

The ideal conditions for maximum savings are:

- Long holding/transport times
- Large volumes
- Frequent use of system
- Large vacuum generators
- Good contact area
- Minimal/no leakages

Example: Amortization

- Basic generator: VADMI-200
- 250 l/min. at 7 bar
- 600,000 cycles/year
- 20 sec./cycle
- 10 sec. transport time
- 75% air saving during transport time

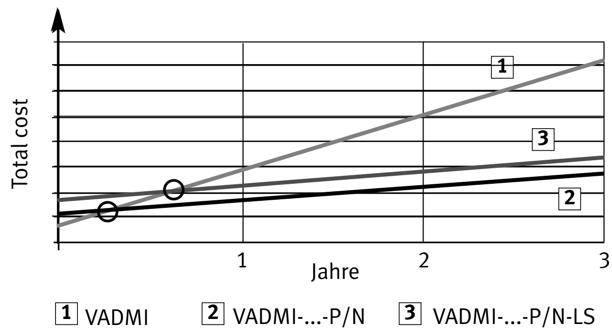


Fig. 5

Conclusion

As the operating time of the generators increases, the ratio between new price and energy costs becomes smaller.

The more of the listed conditions which are fulfilled, the greater the potential for saving. In this case, the higher investment in the purchase of a generator with an energy-saving function in comparison with slightly cheaper generators without an energy-saving function paid for itself after only a short time (see Fig. 5).

Details

Note on the energy-saving function with VADMI-...-P/N

- Conventional vacuum circuit
- Inexpensive energy-saving principle

In the case of the VADMI, first a maximum value is set and then the hysteresis (reliable working range).
The lower limit defines the minimum value.
As long as the vacuum level lies within this range, reliable transport of the workpiece is guaranteed.
The generator is thus activated only when the level falls below the minimum value and is deactivated again as soon as the maximum value is reached.
During the phase in which vacuum generation is inactive, a non-return valve prevents the vacuum level from falling.

Functional sequence

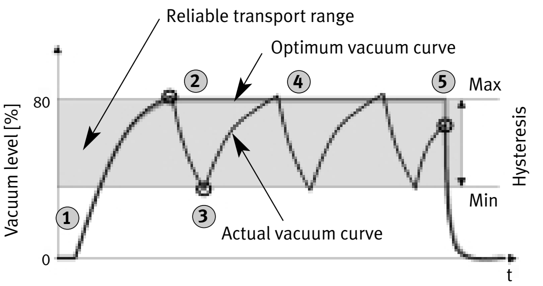


Fig.. 6: Vacuum curve

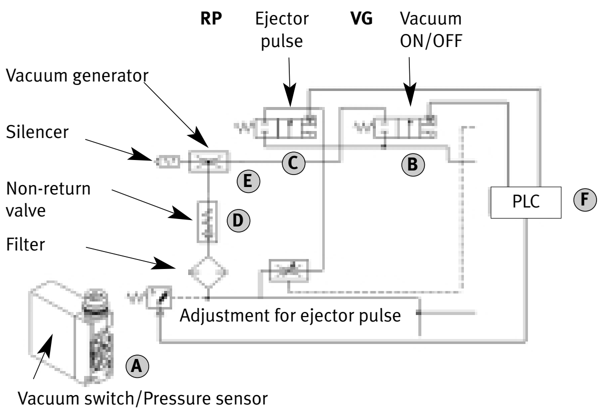


Fig. 7: Block diagram for VADMI

Vacuum ON

1 External controller F switches VG solenoid
  - Valve for compressed-air supply B open
  - Vacuum generator E is activated

Vacuum stop

2 The defined maximum level is reached:
  - Pressure sensor A sends signal to External controller
  - Controller switches VG solenoid off
  - Compressed-air supply stops
  - Vacuum generation interrupted
  - Non-return valve D prevents loss of vacuum level

Vacuum ON

3 Leakage causes fall in vacuum level to minimum value
  - Pressure sensor A sends signal to External controller F
  - Controller F switches VG solenoid B on again
  - Vacuum generator E active again

4 Continuous repetition of steps 2 and 3

Cycle completed

5 Transport operation completed
  - External controller (PLC) F deactivates VG solenoid B
  - Vacuum generation E terminated
  - External controller switches RP solenoid C
  - Vacuum level at 0
  - Workpiece is set down

6 Sequence starts again at 1

Weaknesses of conventional vacuum circuit

- Pressure sensor has only two switching states:
  1. Vacuum level adequate
  ➔ Interrupt vacuum generation
  2. Vacuum level not adequate
  ➔ Activate vacuum generation
  It is thus not possible to provide an indication of the instantaneous value of the level.
- No monitoring to ensure that vacuum level rises back above the minimum level after the generator is activated
  Possible consequences:
  ➔ Unreliable handling operation due to inadequate vacuum level
  ➔ Energy consumption due to constant vacuum generation
- Each individual functional component (pressure sensor, VG solenoid and RP solenoid) must be connected separately to the central control unit.

Note on C. Energy -saving function and alarm with VADMI-...-P/N-LS (see Fig. 8)

Further development of vacuum circuit

As an additional energy-saving measure beyond the functions described above, an alarm is used which is controlled via the pressure sensor unit is the same way as the vacuum circuit.If a suction cup does not grip correctly, or a piece of tubing brakes off, the pressure sensor is able to signal this event to the external control unit (PLC) to allow this or the machine operator to take appropriate action. Thanks to the decentrally-controlled switching function, there is no need for external control of the vacuum circuit (air-saving function) and thus also no need for complex wiring (installation of only 1 cable).

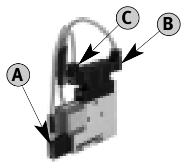


Fig. 8

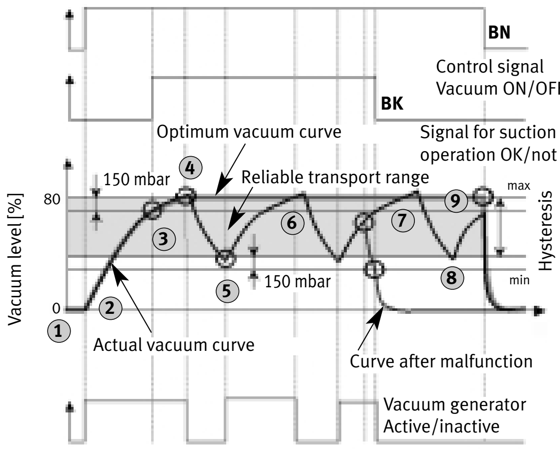


Fig. 9: Vacuum/signal curves

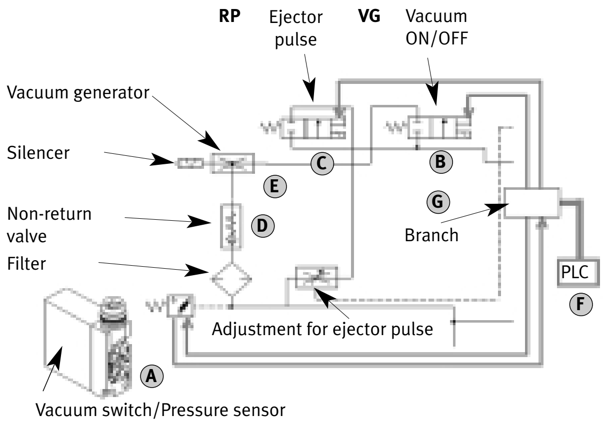


Fig. 10: Block diagram for VADMI-..._LS

Functional sequence

Start signal

1 External controller F activates pressure sensor
- Pressure sensor A monitors vacuum status
- No vacuum present

Vacuum ON

2 Pressure sensor activates VG solenoid B
- Valve for compressed air supply open
- Vacuum generation is activated E

3 Vacuum level exceeds 150 mbar below maximum level
- Pressure sensor sends enable signal to External controller (PLC) F **BK**
- Transport operation can begin

Vacuum stop

4 The defined maximum level is reached
- Pressure sensor A switches VG solenoid off
- Compressed air supply stops
- Vacuum generation E interrupted
- Non-return valve D prevents loss of vacuum level

Vacuum ON

5 Leakage causes vacuum level to fall to minimum value
- Pressure sensor A switches VG solenoid on again
- Vacuum generator E active again

6 Continuous repetition of steps 2 and 3

Malfunction: Transport stopped

7 High leakage causes excessive fall in vacuum level
- Vacuum generator E cannot compensate for fall in level

8 Vacuum level falls 150 mbar below minimum level
- Pressure sensor A sends alarm to external controller (PLC) F **BK**
- External controller terminates transport operation
- Vacuum generation 1 terminated

Cycle completed

9 Transport operation completed
- External controller (PLC) F deactivates VG solenoid
- Vacuum generation E terminated
- External controller F switches RP solenoid C **WH**
- Ejector pulse activated
- Workpiece is set down

Connection to PLC

VADMI-

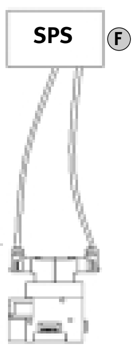


Fig.. 11: VADMI without vacuum circuit

VADMI-...-

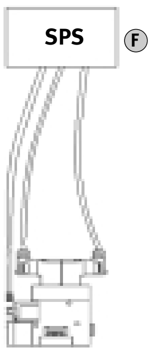


Fig.. 12: VADMI with vacuum circuit

VADMI-...-P/N-

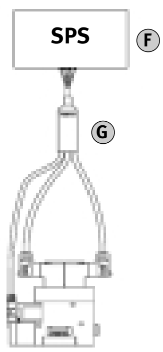


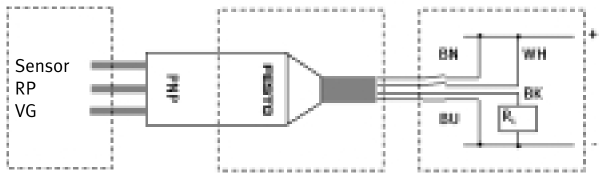
Fig.. 13: VADMI with air-saving circuit

PNP and NPN circuits for VADMI-...-P/N-LS

The three control and power-supply cable trunks are directly grouped into a branch (G) cable via the vacuum generator, which means that only one cable with one signal core and three power-supply cores needs to be routed from the branch to the PLC.
There are two fundamental signal characteristics for external control units (PLCs) and the VADMI-LS which differ only slightly in their mode of operation.
As the vacuum generator and sensor are identical in both versions, the signal flow is only converted in the branch cable.

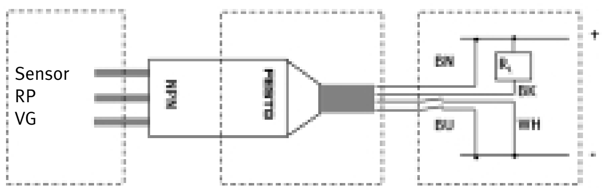
- **The only difference between the model is in the branch cable.**
  The marked plug connectors of the wiring trunk are connected to the appropriate components of the VADMI-LS. The four-cable cable from the branch is connected to the control unit as shown below.

PNP circuit



Cable trunk for VADMI | Branch | **PLC** (supplied by customer)

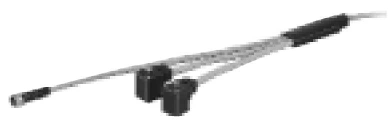
NPN circuit



Cable trunk for VADMI | Branch | **PLC** (supplied by customer)

Legend for both circuits

BN = Brown for vacuum generation **VG**
WH = White for ejector pulse **RP**
BK = Black for load $\mathbf{R_L}$ (PLC)
BU = Blue for ground



Ordering data for the various branch cables

VADMI-	Cable for PNP version	Cable for NPN version
45-LS-	396055	362382
70-LS-		
95-LS-	396054	362380
140-LS-		
200-LS-		
300-LS-		

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