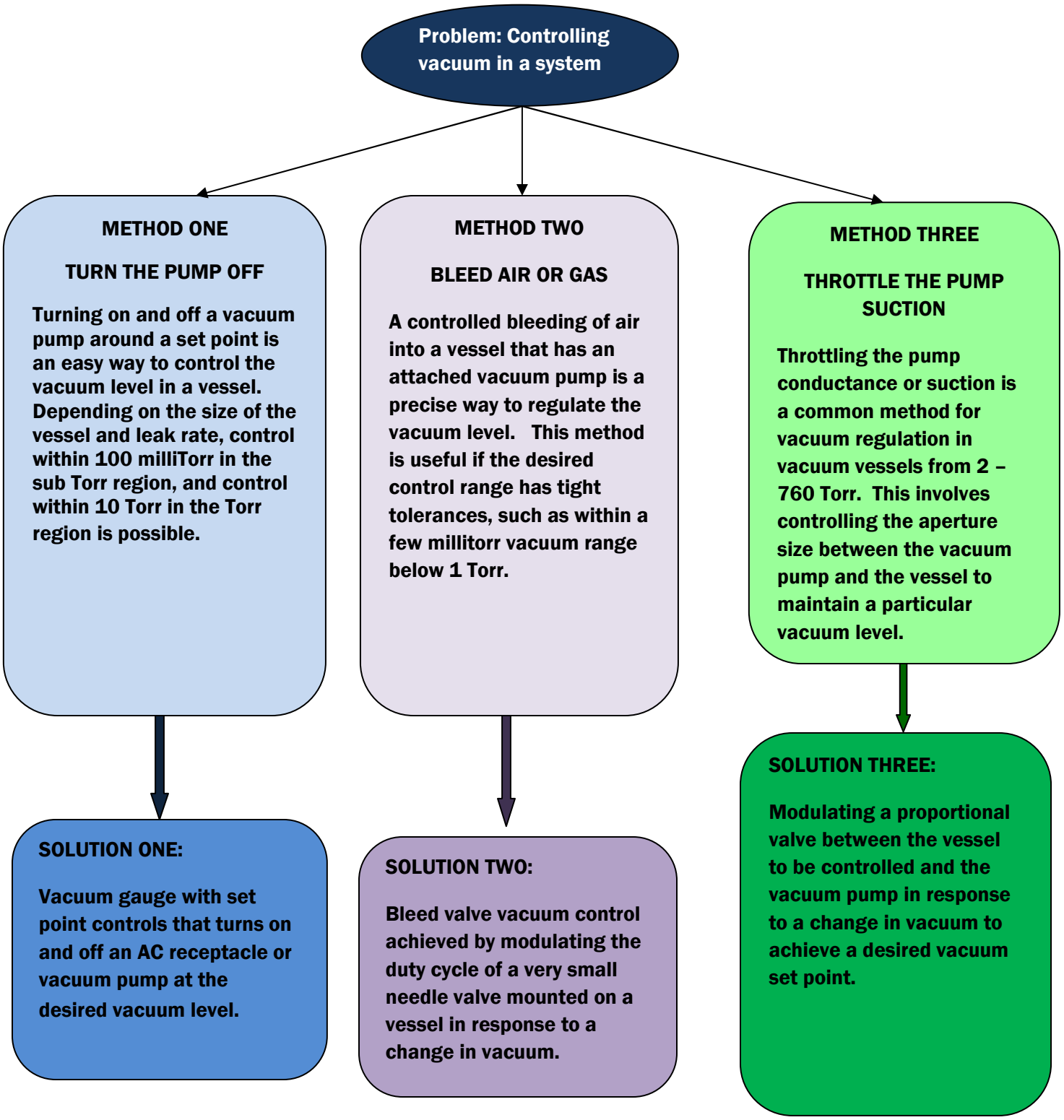
Engineering Solutions to Common Problems



DigiVac
Precise Practical Personal

info@digivac.com P 732.765.0900 F 732.765.1800

Some Notes on the different methods to control the vacuum level in a vessel

All Methods have pros and cons. Below is a short discussion on the Pros and Cons of the methods presented here. Note that there are many creative ways of controlling vacuum, we just present those ways that have worked well for our customers and colleagues. A Hybrid of methods two and three often works well enough that we have a product based on it.

Generally the notion of controlling vacuum involves at the very least a vacuum pump, a vessel to be controlled and some way of regulating the vessel pressure. Sometimes the vessel pressure regulation involves doing something with the vacuum pump, and sometimes doing something with the vessel.

Method one involves very simply turning on and off a vacuum pump at a particular set point. This method employs a configuration where the pump is connected directly to the vessel, and a vacuum gauge is plumbed in a place that minimizes flow seen by the sensor. This is a popular method because of its simplicity. To make this work, you want to make sure that you avoid some of the pitfalls:

- Some pumps surrender oil if stopped and exposed to vacuum.
- Some pump motors can't handle frequent stops and starts.
- Surges may cause electromagnetic interference.
- Make sure that the set point has appropriate hysteresis such that the vacuum pump is not constantly cycling. This would be a property of the vacuum gauge set point control.

Method two is also very simple. This method involves connecting your vacuum pump to your vessel directly, adding a vacuum gauge as above and also plumbing in a bleed valve to the vessel. This method is used in many freeze dryer applications and allows fine control on vessel sizes as small as a 0.245L baby food jar and as large as a 50L chamber. Fine control has been demonstrated to be +/- 1 milliTorr between 30 and 2000 milliTorr. To use this method, a way to control the cycling of the valve is required such as a: freeze dryer, PLC, custom circuit, or product available from some vacuum instrumentation companies. To make this work make sure the basics are addressed:

- Match the vacuum pump to the vessel size to make sure the desired vacuum is achievable in the time frame required.
- Make sure the needle valve is able to achieve the desired vacuum level without being overpowered by the pump. While this often is not a problem, it can be easily overcome by restricting the airflow on the vacuum pump.

Method three is less simple, but often used to control vacuum in the range from 2-760 Torr. This method employs a configuration where a controlled valve sits between the vacuum pump and the vessel, with a vacuum gauge plumbed into the vessel in a place of minimal air flow. This method requires a PLC, custom circuitry or a commercially available controller to throttle the valve based on feedback from the vacuum gauge and the desired set point. In order to make this work, make sure you avoid some of the potential complications:

- Make sure the inherent vessel leak rate is enough to achieve the desired convergence of vacuum level to the set point, otherwise add in a bleed valve.
- Note that house vacuum and type of vacuum pump can make a big difference in optimal control.
- When the vacuum valve opens, it places a load on the pump which may cause it to emit smoke.

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