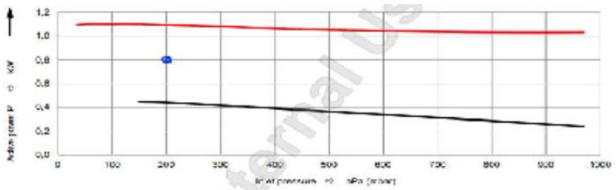
# All Over the World in Industry

# Busch vakuum på Landssygehuset på Færøerne ☺

# Vakuum ejektor – Den skjulte energi synder:

| 15-11-2019 | AGA | MS-33 | | |
|---|---|---|---|---|
| **Drifttid** | | | | |
| Samtidighedsfaktor | 50,00% | | | |
| Timeforbrug | 24 | h/døgn | | |
| Antal dage pr. år | 365 | dage | | |
| **Enegiforbrug vakuumpumpe** | | | | |
| Effekt optaget ca. | 0,8 | kW | | |
| Årligt energiforbrug | 3504 | kWh | | |
| Energiforbrug ca. pris | 2803,2 | kr. | | |
| **Pumpeflow** | | | | |
| Aflæst v. 200 mbar | 0,42 | l/s | | |
| svarerende til | 1,5 | m3/h | | |
| Ved 23 ejec: | 34,5 | m3/h | | |
| Forslag | Mink MV 0040C | | | |
| **Estimeret trykluftforbrug** | | | | |
| Specifik ydelse | 7,10 | kW/(m3/min) | | |
| Optaget trykluft flow | 0,63 | l/s | | |
| Optaget trykluft flow | 0,038 | m3/min | | |
| Optaget trykluft flow (23 ejec) | 0,874 | m3/min | | |
| Optaget effekt | 6,2 | kW | | |
| Drifttimer | 4380 | h | | |
| Årlig forbrug | 27.167 | kWh | | |
| **Besparelse** | | | | |
| Pris kWh | 0,8 | kr | | |
| Besparelse energi | 23.663 | kWh | | |
| Besparelse (kr.) | kr. 18.930,64 | kr/år | | |
| Besparelse % | 87,1% | | | |
| CO2 besparelse | 4.733 | kg | | |
| **Økonomi** | | | | |
| Anskaffelsespris - KUN MV0040 | kr. 23.678,58 | kr | (DG40) | |
| Tilbagebetalingstid | 1,25 | år | = | 15 mdr |
| Tilbagebetalingstid m. energitilskud | 0,88 | år | = | 10,5 mdr |
| Energitilskud | kr. 7.098,99 | kr | | |



Vakuum forsyning drevet af en vakuumejektor er typisk **5 – 10** gange dyrere end traditionelle vakuumpumper alt efter hvilket driftstryk enheden bruges til.

I dette tilfælde med en AGA MS-33 vakuum ejektor målt op imod en Busch Klo-vakuumpumpe MV0040 (40 m3/h).

Årlig energiforbrug:

| | |
|---|---|
| Busch MV0040 | 3.504 kWh |
| AGA MS-33 Ejektor | **27.167** kWh |
| Besparelse ved vakuumpumpe | 23.663 kWh |

Vakuumpumpe løsning er **7,75** gange billigere at drive en vakuum ejektor

# Hospitals vakuum type oversigt:

| Segment | Applikation | Typisk driftstryk | Typisk kapacitet | Anvendte produkter |
|---|---|---|---|---|
| **AZM**<br>Medicinsk vakuum | Kirurgisk sug, thorax dræning, gastrisk sug, laparoskopisk sug | 375 - 200 mbar(a) | 25 - 1000 m3/h | Mink<br>R 5<br>Cobra |
| **AZL**<br>Laboratorie teknisk vakuum | Tørring, filtrering, væske overførsel, stinkskab evakuering, test af medico teknisk udstyr | 350 - 100 mbar(a) | 25 - 1000 m3/h | Mink<br>R 5<br>Cobra |
| **AGS**<br>Anæstesisug | Evakuering af anæstesigasser med højt iltindhold | EU: 900 - 650 mbar(a)<br>US/CAN: 400-300 mbar(a) | 25 - 600 m3/h | EU: Samos<br>US/CA: Mink, R 5<br>(Oxygen, O2 ready) |
| **DIS**<br>Diatermisug | Evakuering af røg fra el-kirurgi under operationer | 600 - 300 mbar(a) | 25 - 200 m3/h | Mink<br>R5<br>Seco |

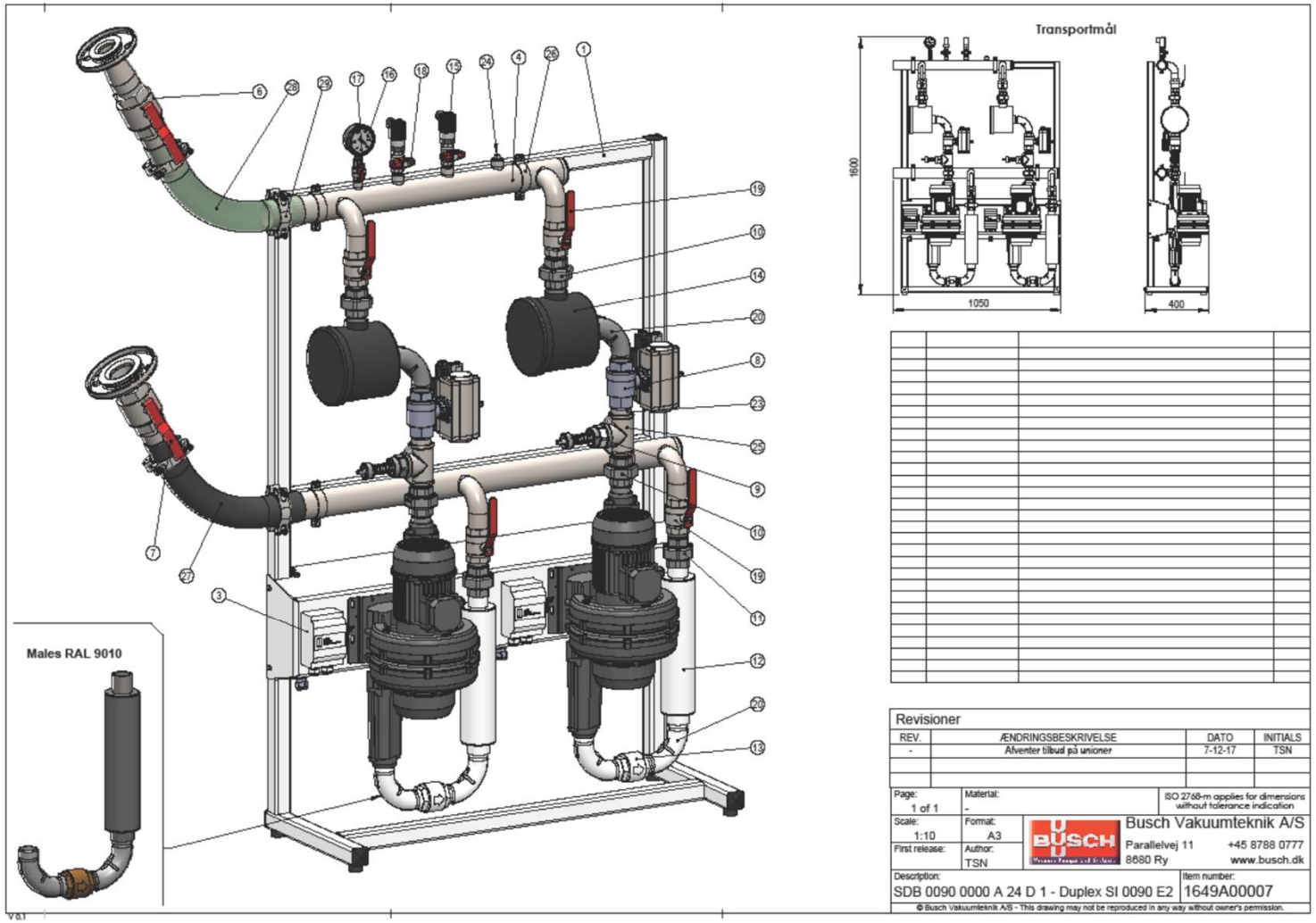
# Et traditionelt AGS vakuumsystem fra Busch

## med vakuumstyring



# Et traditionelt AGS vakuumsystem fra Busch

## Vakuumstyring ikke vist på dette billede

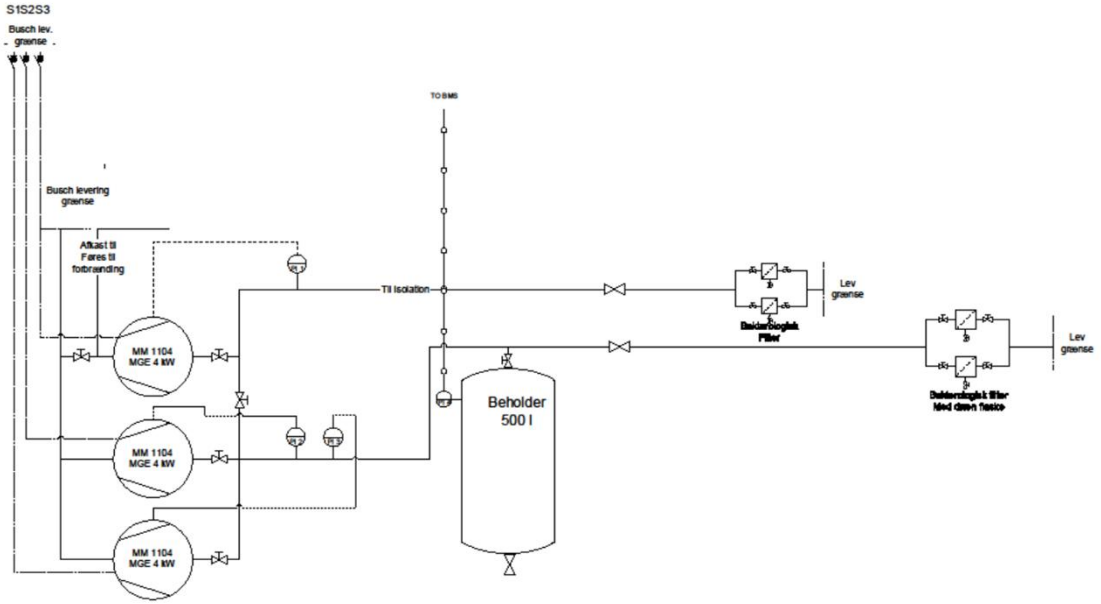


# Et traditionelt AZM vakuumsystem fra Busch

## Jf. EN/ISO 7396-1

# Eksempel på alternativ AZM vakuumsystem fra Busch

## Alle Busch vakuumsystemer er kundetilpasset




Minimum 3 enheder til vakuumforsyning. Eksempelvis primær-enhed, sekundær-enhed og reserve-enhed

Hver enhed kan bestå af en eller flere pumper.

Såfremt hver enhed består af kun en pumpe, skal disse hver især kunne levere et flow svarende til 100 % forbrug.

Såfremt hver enhed består af mere end en pumpe, skal der kunne skiftes mellem enhederne, så der til en hver tid kan leveres det krævede flow i tilfælde af vedligehold eller udfald af pumpe.

Mindst 1 vakuumbeholder

Mindst 2 bakteriologiske filtre der hver har en kapacitet svarende til minimum 100 % flow


Busch Vakuumteknik A/S
Parallelvej 11, 8680 Ry
Tlf. +45 87 88 07 77
Fax. +45 87 88 07 88


KTM 1104 0500 AZM MGE

# Spørgsmål:

- Hvorfor følger man ikke ISO standarden 7396-2?
- Hvorfor vil de danske sygehuse og rådgivere ikke følge ISO standarden?
- Hvorfor ser man AGS systemer tilkoblet til AZM anlæg, når det står i ISO standarden, at man ikke må???

# Hvad siger ISO 7396 overordnet

The objectives of this part of ISO 7396 are to ensure the following:

a) avoidance of cross connections between different pipeline systems;

b) continuity of function of the system;

c) use of suitable materials;

d) cleanliness of components;

e) correct installation;

f) provision of indicating system(s);

g) correct marking of the pipeline system and components;

h) testing, commissioning and certification;

i) correct operational management.

# Hvad siger ISO 7396-2 om AGS systemers udførelse?

## 4.3 Materials

**4.3.1** The materials used for pipelines and other components of the disposal system shall be corrosion-resistant and compatible with anaesthetic gases and vapours under the operating conditions specified by the manufacturer.

NOTE 1 Corrosion resistance includes resistance against the influence of moisture and the surrounding materials.

**5.5** Power devices consisting of fans, blowers or dedicated vacuum pumps shall not be located in the same room as gas and non-cryogenic liquid cylinder supply systems.

**5.6** The locations of power devices complying with this part of ISO 7396 and supply systems complying with ISO 7396-1 shall be decided by risk management process in accordance with ISO 14971 in order to minimize the risk arising from hazards such as fire, contamination with oil, grease, and increased oxygen and nitrous oxide concentrations.

If dedicated vacuum pumps are installed as power device(s), they shall be compatible with oxygen and the anaesthetic gases and vapours.

(*) A vacuum supply system in accordance with ISO 7396-1 shall not be used as AGSS power device.

# AGS systemers udførelse i USA/Canada

Efterfølgende slides handler om et bedre analyse arbejde før man beslutter hvordan et AGS systemers udførelse.

Det er vigtigt, at man forholder sig til hvilket AGS udstyr, der skal installeres på de respektive stuer på sygehuset.

Der kan ske fejl, hvis man ikke forholder sig til f.eks til de blandings gasser der kan komme eller forhøjet ilt indhold i AGS systemet, derfor er materiale valg vigtige, da der ellers kan være forhøjet brandrisiko eller gas forurening.

**I Danmark har vi indtil nu ikke fuldt disse regler 100 %**

**I Danmark handler det desværre kun om, at slippe afsted med, at lave et hospital billigst mulig, og at ikke om at følge de respektive regler og overholde sikkerheden bedst muligt**

# Best Practices for Centrally Piped Medical Gas Systems

## Toronto

## Anaesthetic Gas Scavenging System (AGSS) Sizing

Busch Canada

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# AGSS sizing
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# AGSS sizing
## Why AGSSs and why dedicated AGSSs

### Why AGSSs?
To convey expired or excess oxygen and anaesthetic gases to an appropriate place of discharge.
Typical anaesthetic gases (volatile halogenated ethers) include:

| Generic or Chemical name | Commercial name |
|---|---|
| Nitrous oxide | Nitrous oxide |
| Halothane | Fluothane® |
| Enflurane | Ethrane® |
| Isoflurane | Forane® |
| Desflurane | Suprane® |
| Sevoflurane | Ultane® |

### Why a dedicated AGS System
The new Z7396.1-12 includes requirements for AGSSs. These are separated from medical vacuum systems in recognition of the following hazards that have been identified with dual use systems:

- fires in lubricated pumps related to oxygen-enriched environments;
- hazards to patients resulting from excess vacuum at the AGSS interface; and
- increased demand on vacuum pumps resulting from changes in AGSS practices.

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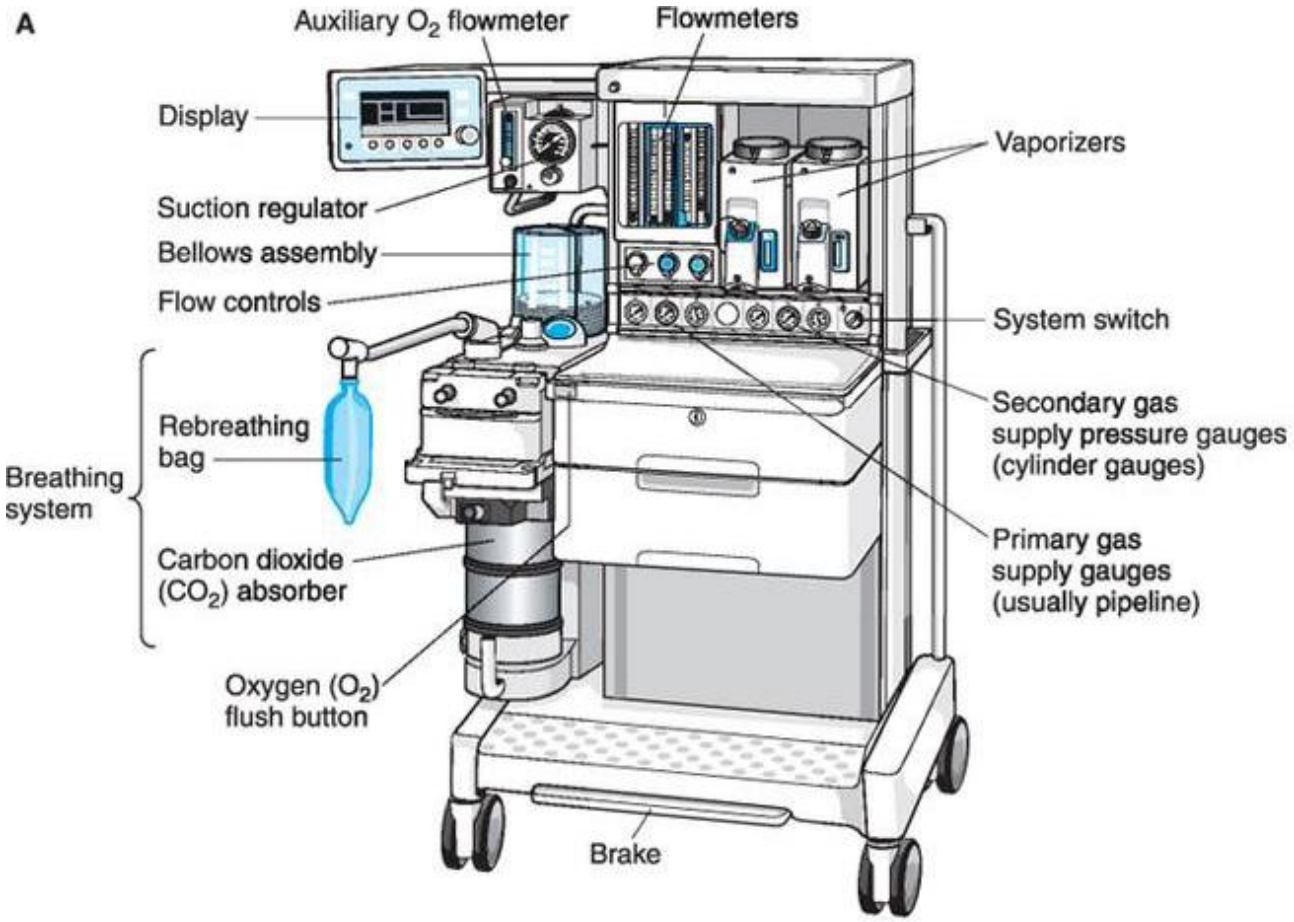
# AGSS sizing
## How AGSS works



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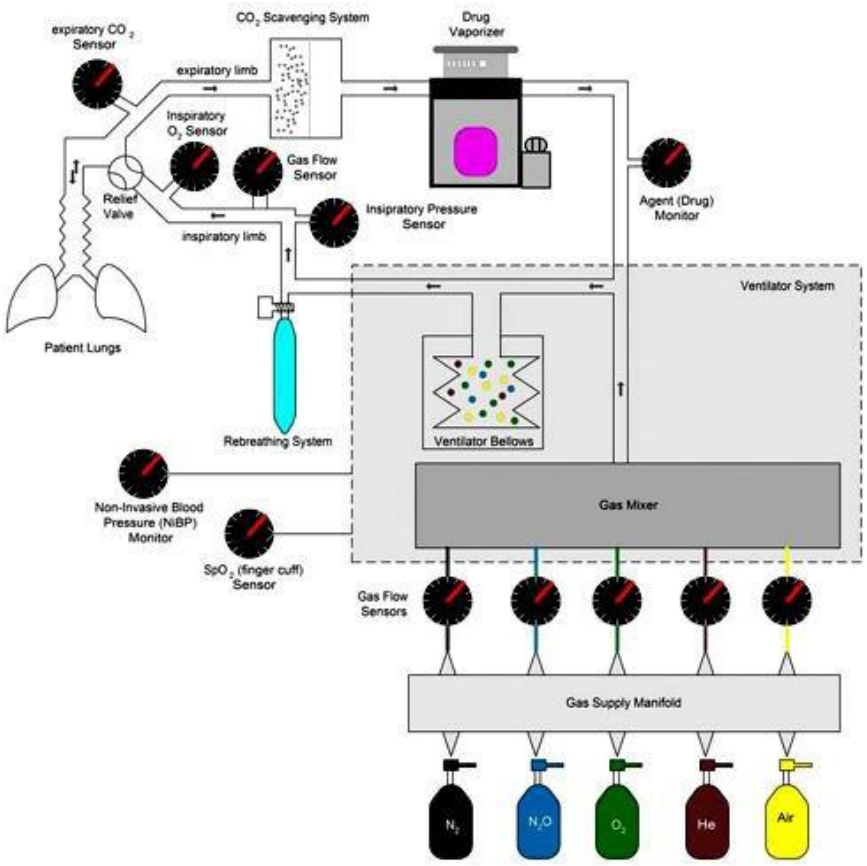


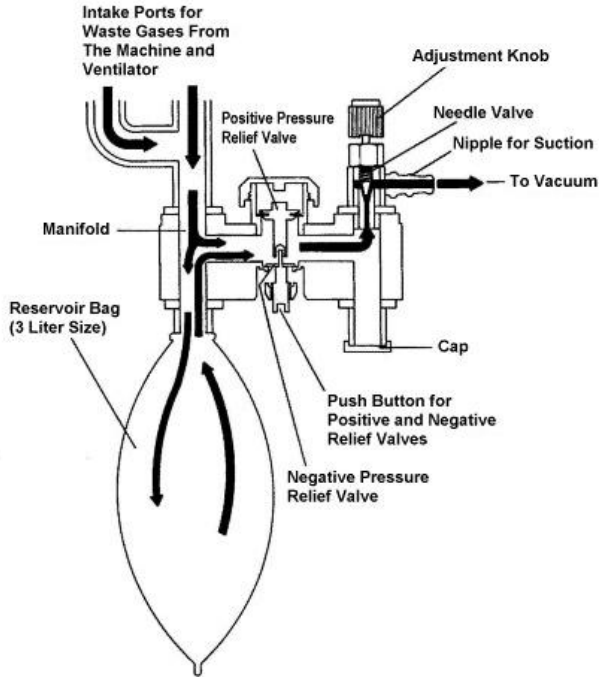

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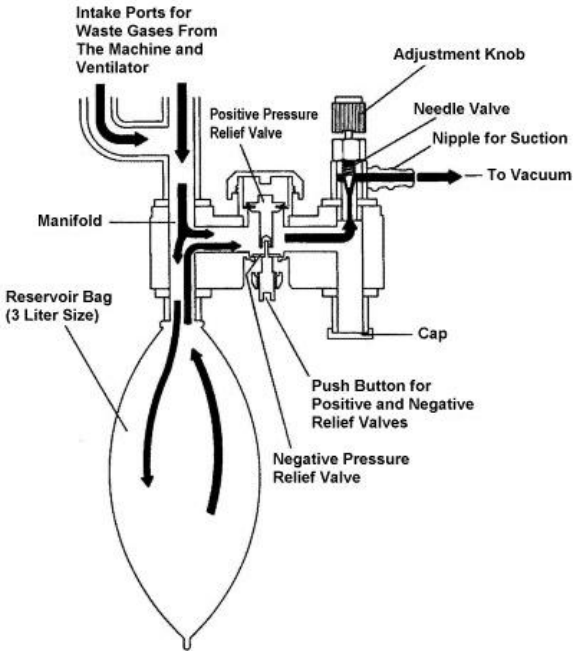


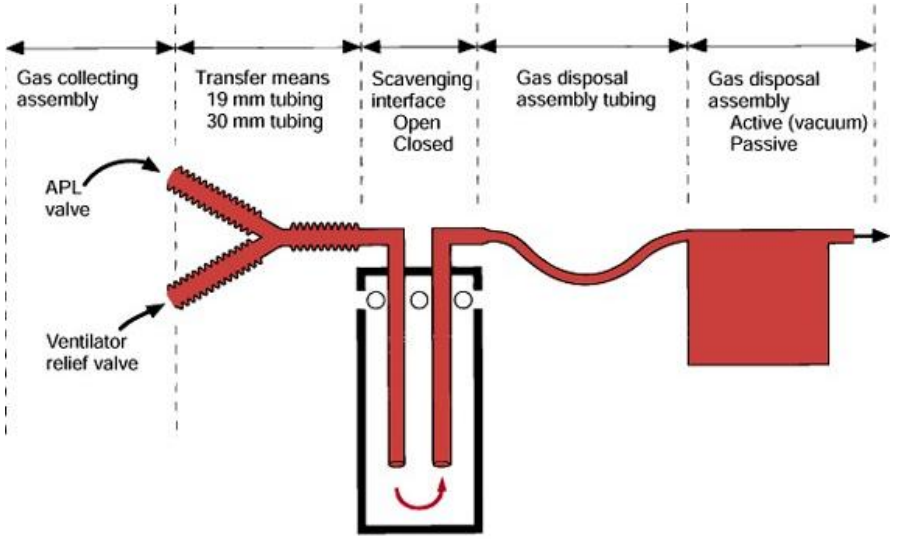


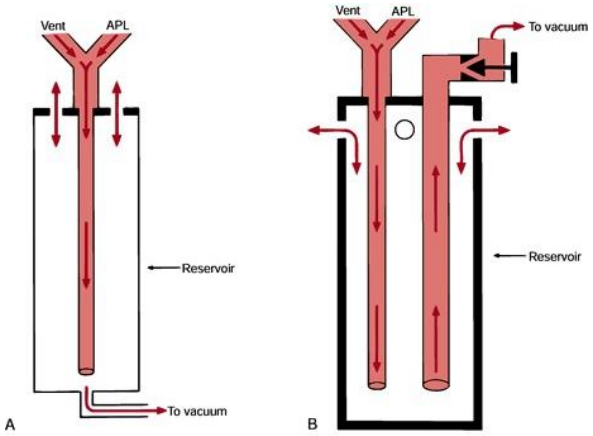

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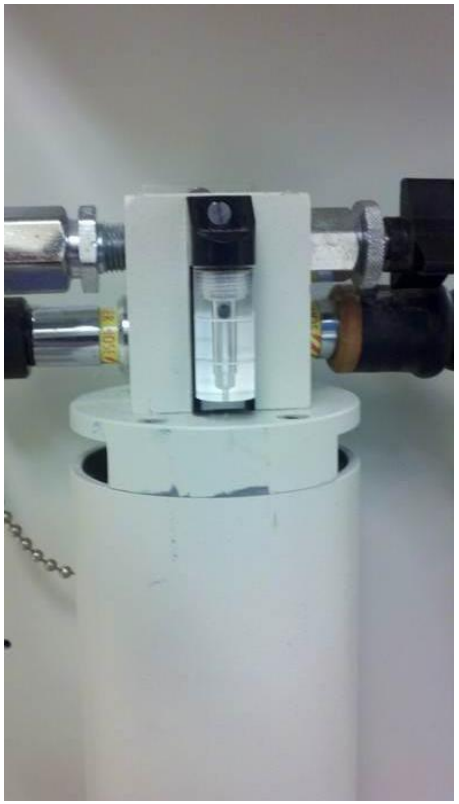

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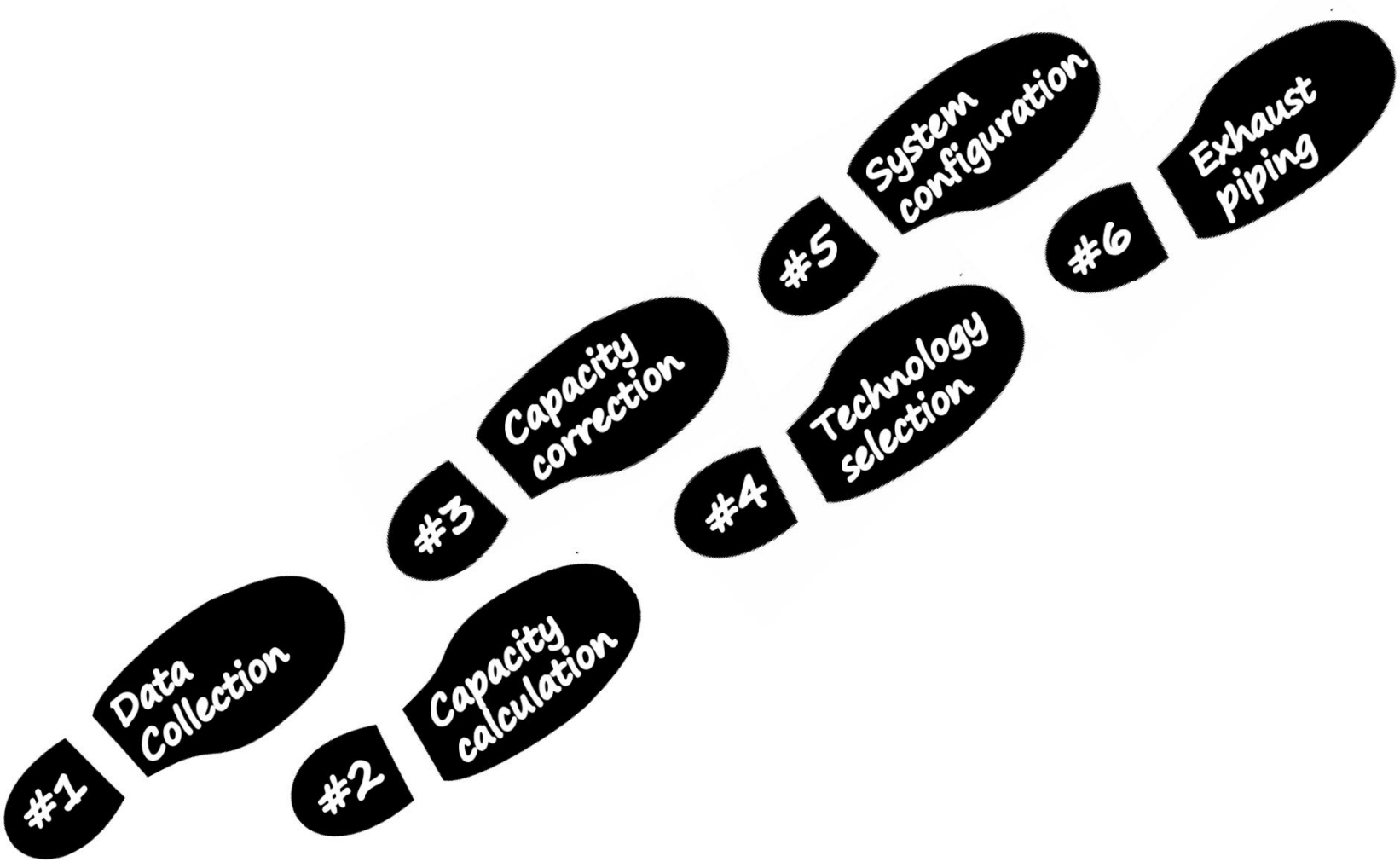
# AGSS sizing

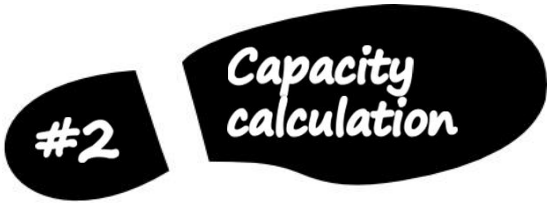
## The 6 steps to AGSS sizing



# AGSS sizing

## The 6 steps to AGSS sizing


List all anaesthetic machines that will or can be connected to the AGSS. List the associated manufacturer required flow capacity.

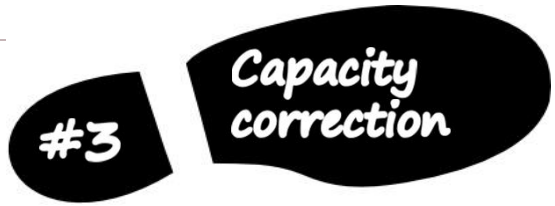



Based on the equipment list obtain at step #1, determine the total demand for the supply system.

- If the manufacturer required flow capacity is unknown, use 25 to 50 l/min per machine (50 l/min being the most used value for sizing purpose).
- Most active AGSSs are sized to operate between 12 and 25 inHgV (12 inHgV being the required minimum vacuum level by most anaesthetic machine manufacturer). *ca 400-800 mbar*

# AGSS sizing

## The 6 steps to AGSS sizing




a) Capacity correction factor #1 – Altitude *(important for sites 500 m + above sea level)*

When a vacuum pump operates at altitudes greater than sea level, the performance of the pump is reduced. Please consult the Medical Vacuum System Sizing Presentation to understand how to correct the required capacity for altitude.

b) Capacity correction factor #2 – The Future

AGSSs are purchased to operate for 20 and even 25 years. Will future construction projects, renovations and/or additions impact the required capacity of the vacuum system during those years? It is often wise to add excess capacity to the system and/or build in some expandability.

Whether it's adding 10 to 20% to the calculated capacity and/or by designing the vacuum system with a control panel ready to accept an extra pump in the future, it is of paramount importance to plan for the future.

# AGSS sizing

## The 6 steps to AGSS sizing


Currently, 4 main technologies are being offered on the Canadian market today for active AGSS (all manufacturers combined)

a) Dry rotary claw pumps
b) Oil-Lubricated rotary vane pumps
c) Liquid ring vacuum pumps
d) Dry rotary vane pumps

To select the right technology for your facility, you must take into account all the pros and cons.

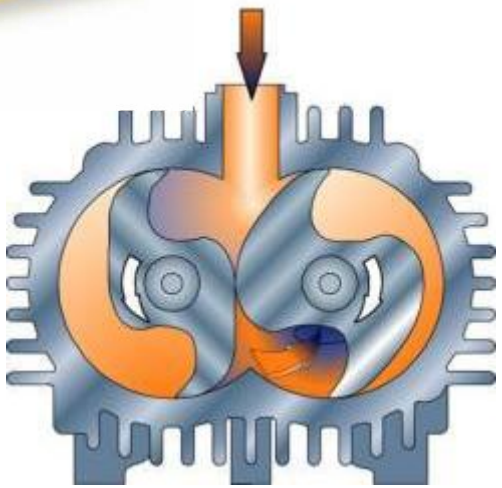
# AGSS sizing

## The 6 steps to AGSS sizing


Dry rotary claw pumps


**Pros**

- **Dry, oil-free, non-contacting**
- **Low power consumption**
- **Minimal and easy maintenance**
- **Lowest cost of ownership**
- **Available in Oxygen-Assured version**
- Simple design
- Consistent flow performance through time
- Easy flow control via VFD



**Cons**

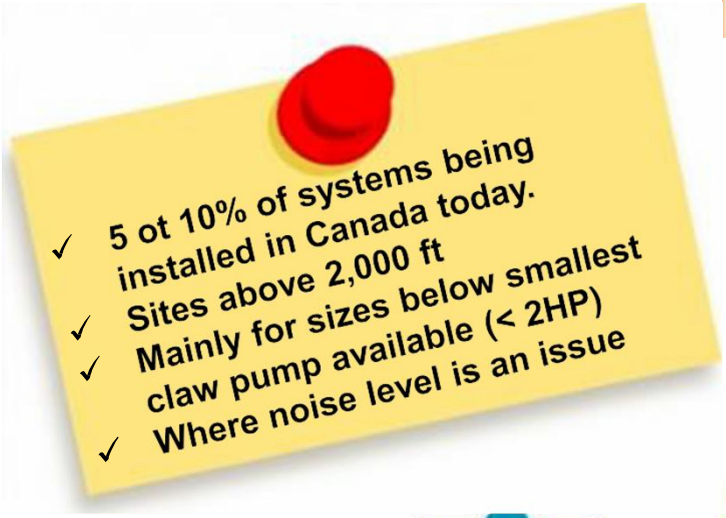
- Sound level

**CSA Z7396.1-12, s. 5.10.2.1 General**
Vacuum producers shall be of the oil-less, oil-free, or water-sealed type. Manufacturers shall disclose, upon request, evidence of the compatibility of the producers with the oxygen-enriched anaesthetic gas stream under operating conditions.

# AGSS sizing

## The 6 steps to AGSS sizing


Oil-Lubricated rotary vane pumps

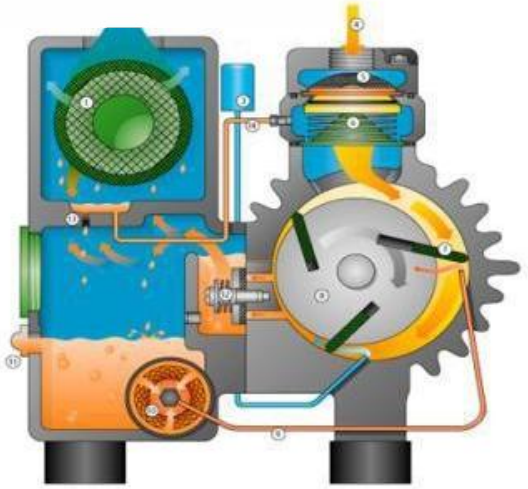



**Pros**

- **High vacuum capability**
- **Quiet**
- **Available in Oxygen-Assured version with Fomblin Lubricant**
- High efficiency
- Low installation cost
- Simple design and field repairable

**Cons**

- Larger volume of Fomblin ($$$)



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# AGSS sizing

## The 6 steps to AGSS sizing


Dry rotary vane pumps


**Pros**

- Low initial and installation cost
- No oil, low maintenance
- Small footprint
- Simple design and field repairable

**Cons**

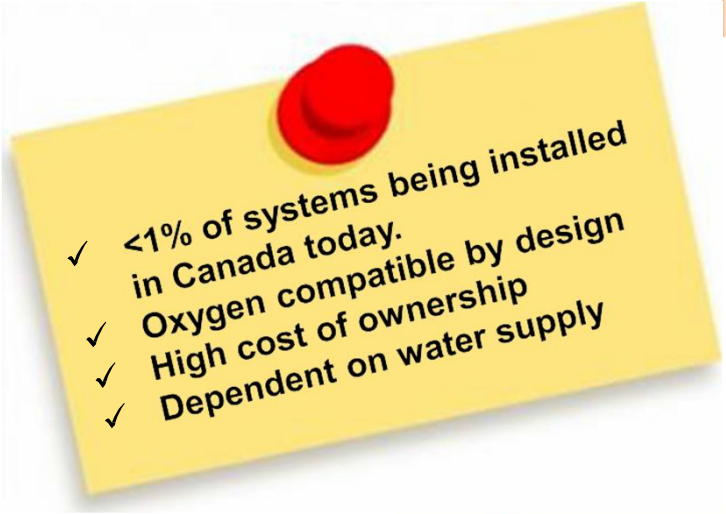
- Low flow at 19 in. Hg
- **Not available in Oxygen-Assured version**
- **Vane and cylinder wear**
- **Decreased performance with time**
- **Possibility of catastrophic failure**
- **Application limited by altitude**

**CSA Z7396.1-12, s. 5.10.2.1 General**
Vacuum producers shall be of the oil-less, oil-free, or water-sealed type. Manufacturers shall disclose, upon request, evidence of the compatibility of the producers with the oxygen-enriched anaesthetic gas stream under operating conditions.

# AGSS sizing

## The 6 steps to AGSS sizing


Liquid ring vacuum pump




**Pros**

- Simple design and low cost
- Applicable for oxygen duty
- Tolerant to higher ambient temperatures

**Cons**

- **Water consumption**
- **Inefficient**
- **Not capable of high vacuum**
- **Ambient water temperature dependant**
- **High system maintenance**
- **Cannot operate with disruption in water supply**

# AGSS sizing

## The 6 steps to AGSS sizing


When selecting a system configuration, many factors must be considered.
Amongst them, the most important are:

1) Space and height limitations and existing housekeeping pad
2) Maintenance access and serviceability
3) Initial cost

Standard system configurations available are:

- ✓ Small capacity systems !
- ✓ No extra steel frames (cost saving$)
- ✓ Mainly for duplex config.

Tank mounted systems

- ✓ 80% + of systems
- ✓ With or without receiver
- ✓ Can accommodate any number of pumps
- ✓ Compact
- ✓ Designed with contractors in mind

Stack mounted systems

# AGSS sizing

## The 6 steps to AGSS sizing


a) Exhaust location

Determine the building vacuum discharge location. Please refer to CAN/CSA Z7396.1-12 s. 5.10.3.1.4, 5.10.3.1.5, and A.5.10.3.1.5 to properly select a suitable and safe discharge location.

b) Equivalent exhaust pipe length

Determine the required pipe length to go from the vacuum system to the selected exhaust location. Account for all elbows, tees and valves using an equivalent pipe length chart.

c) Exhaust pipe diameter

Once the equivalent exhaust pipe length is determined, you can select the appropriate pipe diameter using the table 6.1 below. (677mbara)

**Table 6.1 – Exhaust pipe diameter**

| System Capacity | Equivalent Pipe Length(feet) | | | | | | |
|---|---|---|---|---|---|---|---|
| SCFM @ 20 inHgV | 50 | 100 | 150 | 200 | 300 | 400 | 500 |
| | Exhaust pipe size (inches) | | | | | | |
| 10 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 50 | 2 | 2.5 | 3 | 3 | 3 | 3 | 3 |
| 100 | 3 | 3 | 3 | 4 | 4 | 5 | 5 |
| 150 | 3 | 4 | 4 | 4 | 5 | 5 | 5 |
| 200 | 4 | 4 | 4 | 5 | 5 | 5 | 5 |
| 300 | 4 | 5 | 5 | 5 | 6 | 6 | 6 |
| 400 | 5 | 5 | 6 | 6 | 6 | 8 | 8 |

# AGSS sizing
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# AGS sizing
## Conclusion

- Sizing and selecting the proper AGSS is a simple, yet methodical process.
- The process includes 6 important steps
- All of these steps should always be carried out with the owner/user in mind.
- A typical AGS system will have a 20 year life expectancy. Select your system carefully!