變頻真空技術與節能實例
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AGENDA

- 真空技術簡介
- 變頻真空技術
- 節能實例
Pump Types in Rough Vacuum
‘Perfect’ Vacuum

- The ‘perfect’ vacuum doesn’t exist: 0 mbar(a) absolute is not reachable!

**Rough vacuum**
1013 mbar(a) – 1 mbar(a)

**Medium vacuum**
1 mbar(a) – 10⁻³ mbar(a)

**High vacuum**
10⁻³ mbar(a) - 10⁻⁷ mbar(a)

**Ultra-high vacuum**
10⁻⁷ mbar(a) - 10⁻⁸ mbar(a)

*Standard Vacuum Ranges (ISO 3529)*
Different Pumps, Different Applications

Dry claw (VSD) 乾爪式(變頻)真空機

Oil sealed rotary screw VSD 螺桿式變頻真空機

Oil sealed rotary vane - 1 stage 單段油式真空機

Oil sealed rotary vane - 2 stage 雙段油式真空機

Liquid ring 水封式真空機

Rough Vacuum

Utility Vacuum

Pressure mbar(a)

5x10^-3 0.5 1 200 400 600 800 1000

Atmospheric
Vacuum Pump Types

- Liquid ring pump
- Dry claw pump
- Oil vane pump
- Oil screw pump
OIL SEALED ROTARY VANES

Characteristics

- Proved technology
- Efficiency?
  - Vanes = wearing parts
  - Critical eye on marketing curves -> performances given without inlet filter,…
  - Few variable speed machines with limited motor speed range
    - Not easy to control with VSD
    - Turn down ratio is limited
- High noise level
Rotary Vane Pump
Liquid ring vacuum pump principles

Principle of operation

- Impeller
- Casing
- Service liquid
- Shaft
- Inlet port
Water in vacuum
Liquid ring pump - water ring

- Robust technology
  - Big tolerance
  - can handle dust, liquid and vapors
  - Ideal for wet/humid applications
  - Big range of capacities
  - Maintainability

- Efficiency?
  - Closely linked to the water temperature
  - External system (chiller) required to cool the water
  - Efficient in humid application thanks to the condensation effect
Variable Speed Driven : VSD+
**Variable speed**

- A vacuum process is never constant.

- What happens with a Fixed Speed machine?
  
  A Fixed Speed machine **cannot adjust its rotor speed** so:
  - if the demand from the process increases, the pressure in the system increases
  - if the demand from the process decreases, the pressure in the system decreases

- What happens with a Variable Speed machine?
  
  A Variable Speed adjusts the rotor speed to match the demand coming from the process and **maintain a constant pressure**
  - if the demand from the process increases, the VSD machine accelerates
  - if the demand from the process decreases, the VSD machine slows down
Slow down instead of running at ultimate

Power at ultimate pressure

Ultimate pressure
With a **Fixed Speed**, when the demand from the process reduces:
- As the Fixed Speed machine cannot adjust its speed
- The pressure goes down, the pump is running at lower pressure than needed
- … and still consumes a lot of energy!

**In fact:** for an OIV, the power at the ultimate pressure is around **60% of the max power**.

- In the worst case, the pump keeps running at **ultimate pressure**.
- The frequent mistake is to believe that at the ultimate pressure, the pump **consumes nothing**?
With a VSD machine, when the demand from the process reduces:
- The pressure stays constant
- The machine slows down and the power goes down significantly!

**VARIABLE SPEED**
With a VSD machine, if the demand comes down to 25%, the power consumed comes down to 25%.

With a VSD pump, the energy consumption matches with the demand!
Design of GHS VSD+
Best in class efficiency

- The GHSVSD+ delivers an average of 50% energy savings compared to traditional vacuum pumps.

- This is achieved by:
  - Start Up Current Limitation.
    - Inlet control valve
  - Efficiency Gain With Oil Injected Screw Element.
    - Rotor technology
  - VSD Matching / Following the Demand
    - Frequency controller
  - Stable Pressure Set Point
    - Holding pressure tracking
GHS VSD+ diagram & key components
Efficient oil injected screw technology

- The compression stage or Element, is based on a proven design used in our compressors with minor machining differences.
- Components are designed for use in +13bar pressure deferential applications and offers extreme durability in -1 bar vacuum applications.
- There are no wearing parts like vanes and thus efficiencies will remain constant over the life of the element.
Multi function inlet control valve

- Integral Non Return Valve
- Modulating Flow Control Valve
- Limits Exhaust Filter Overload
- Limits Start Up Current
- Works in Conjunction with VSD Inverter to limit energy consumption.
**Variable speed**

- VARIABLE SPEED DRIVE
  - When the pressure change the GHS VSD+ will adjust and optimize operation, matching the demand and power requirement exactly.
Elektronikon MK5 GRAPHIC

- All the functionalities of the Atlas Copco Elektronikon MK5 Graphic:
  - Runnings hours
  - Counters with speed range
  - Preventive maintenance
  - .....
How does the GHS VSD+ save energy

Due to innovative components, Multifunction inlet valve, MKV Electronicon Controller, Oil Injected Screw Technology and Variable Speed Drive, the GHSVSD+ can precisely control and limit the energy use.

Potential Energy Savings

Current GHSVSD+  Current Traditional
Successful Stories
**Semicon - Lithography**

- **Application:**
  - Vacuum is used to pick & place wafer
  - Previous: 2 x Busch R5 0202 6.6KW

- **New:** 2 x GHS 585 VSD+ (10HP): 7.6 KW
  - Vacuum level: 100 mbar absolute

- **Key to success:**
  - >42% energy saving;
  - Noise level
  - No buffer tank
  - Low maintenance
  - Oil leakage & over heating issues

Before 13.2 KW
After 7.6 KW

>42%
SEMICON ASSEMBLY & TESTING

- **Application:**
  - Vacuum is used to pick & place wafers
  - Previous: Sullair VS-16-30 (30HP) x2
- **New:** 2 x GHS 900 VSD+ (20HP) : 9.5 kW
  - Vacuum level: 50mbar absolute (60% loading)
- **Key to success:**
  - >58% energy saving;
  - Noise level;
  - No water consumption;
  - Low maintenance
  - Oil leakage issue.

Before 45 KW

After 19 KW
**OLED**

- **Application:**
  - Vacuum is used to pick & place OLED
  - Previous: 2 x Nash 60Hp

- **New:** 2xGHS 900 VSD+ : 30 kW
  - Vacuum level: 200 mbar absolute (30 % loading)

- **Key to success:**
  - >67 % energy saving;
  - Noise level;
  - No water consumption
  - Low maintenance
  - Water leakage issue.
SEMICON ASSEMBLY & TESTING

- Application:
  - Vacuum is used to pick & place wafers
  - Previous: Nash 50Hp

- New: 1 GHS 1300 VSD+: 22 KW (60% loading)
  - Vacuum level: 100 mbar absolute

- Key to success:
  - >64% energy saving;
  - Noise level;
  - No water consumption
  - Low maintenance;
  - Water leakage issue.
致力於實現可持續的生產力。