



Application of Frequency Converters – simple way to energy saving

3RD INTERNATIONAL WORKSHOP - MOTOR CHALLENGE PROGRAMME

Wrocław 2008.11.19

Andrzej Gizicki- Key Account Manager

Danfoss sp. z o.o.(Poland)



A variable speed drives (frequency converters) converts the electrical power supply from fixed voltage and fixed frequency to a variable voltage and frequency – making it possible to adjust the speed of a standard electrical motor.

Key benefits of modern VSD's are:

- Large energy savings by controlling the speed of e.g. pumps, fans, compressors, conveyors
- Increased production by optimization of the plant operation
- Less and less expensive to buy, install and to operate

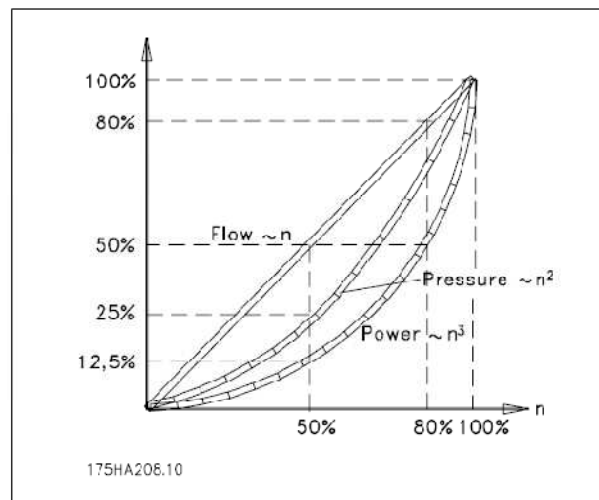
The characteristics for motor and machine are stated as the ratio between speed and torque or output.

The torque characteristics of machine are influencing on energy demand.

VSD have a possibility to adaptation of output values (voltage, frequency, current) suitable to technological needs.

The most convenient to energy saving as a consequence of speed control are pumps and fans.

The basic dependences for pumps and fans:



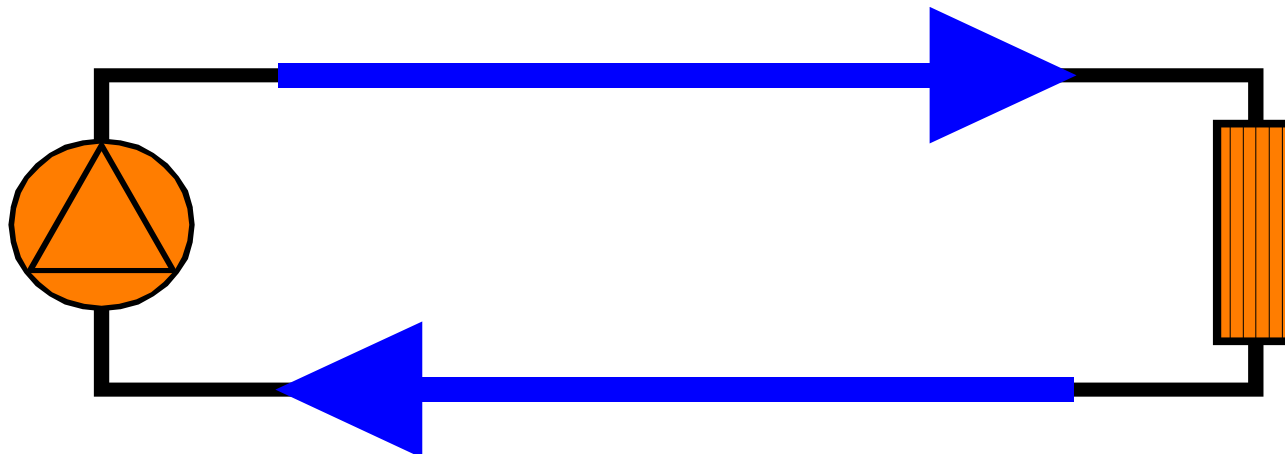
$$\text{Flow} : \frac{Q_1}{Q_2} = \frac{n_1}{n_2}$$

$$\text{Pressure} : \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2$$

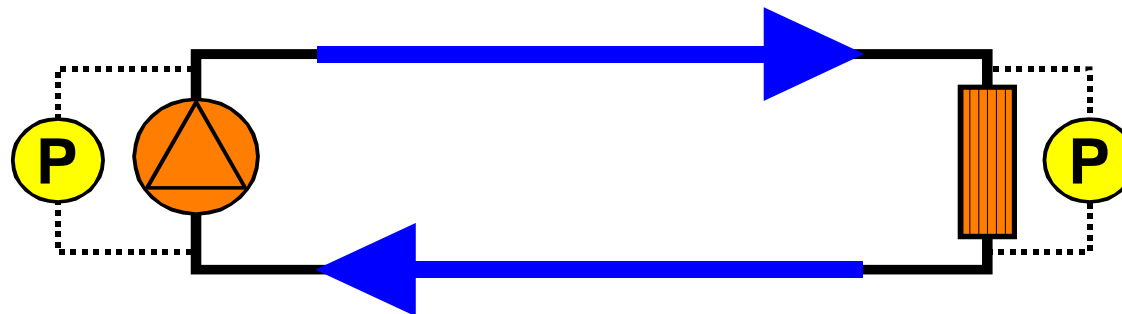
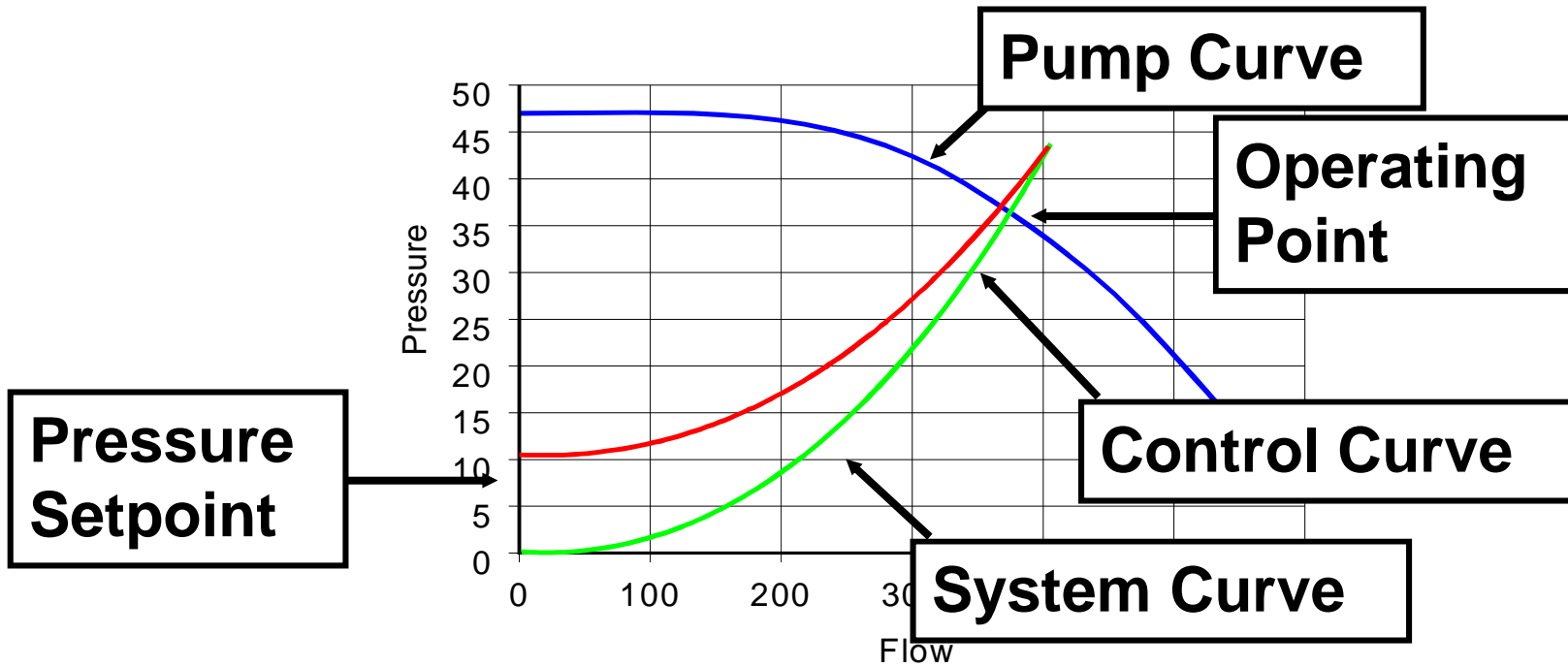
$$\text{Power} : \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3$$

Why Adjustable Speed?

- Energy savings
 - Secondary pumping example

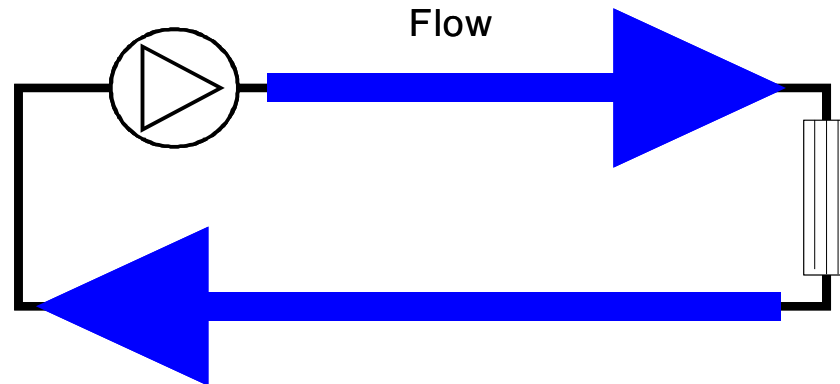
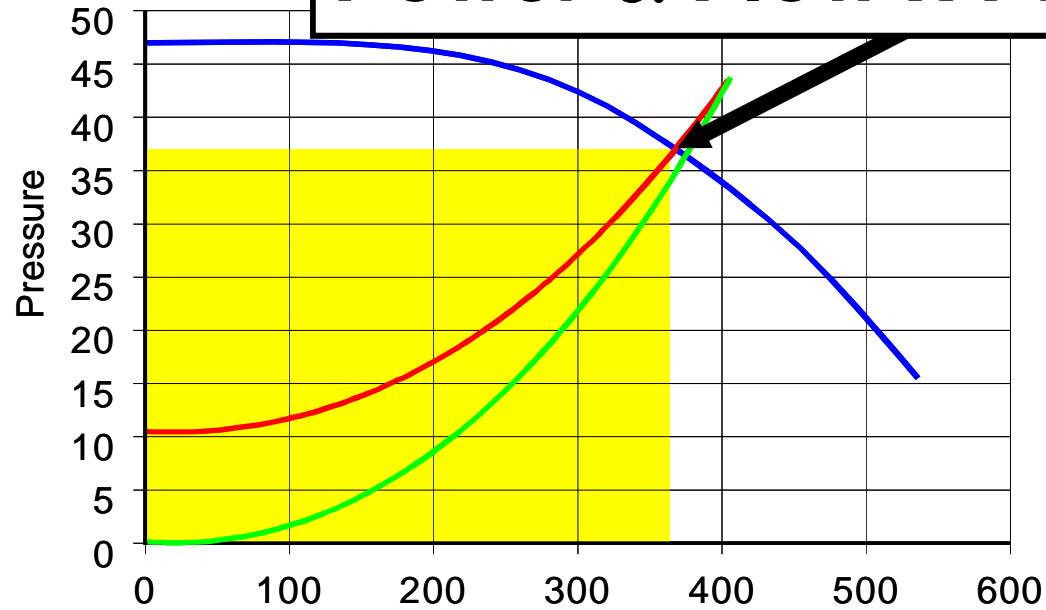


Energy Requirements Important Curves

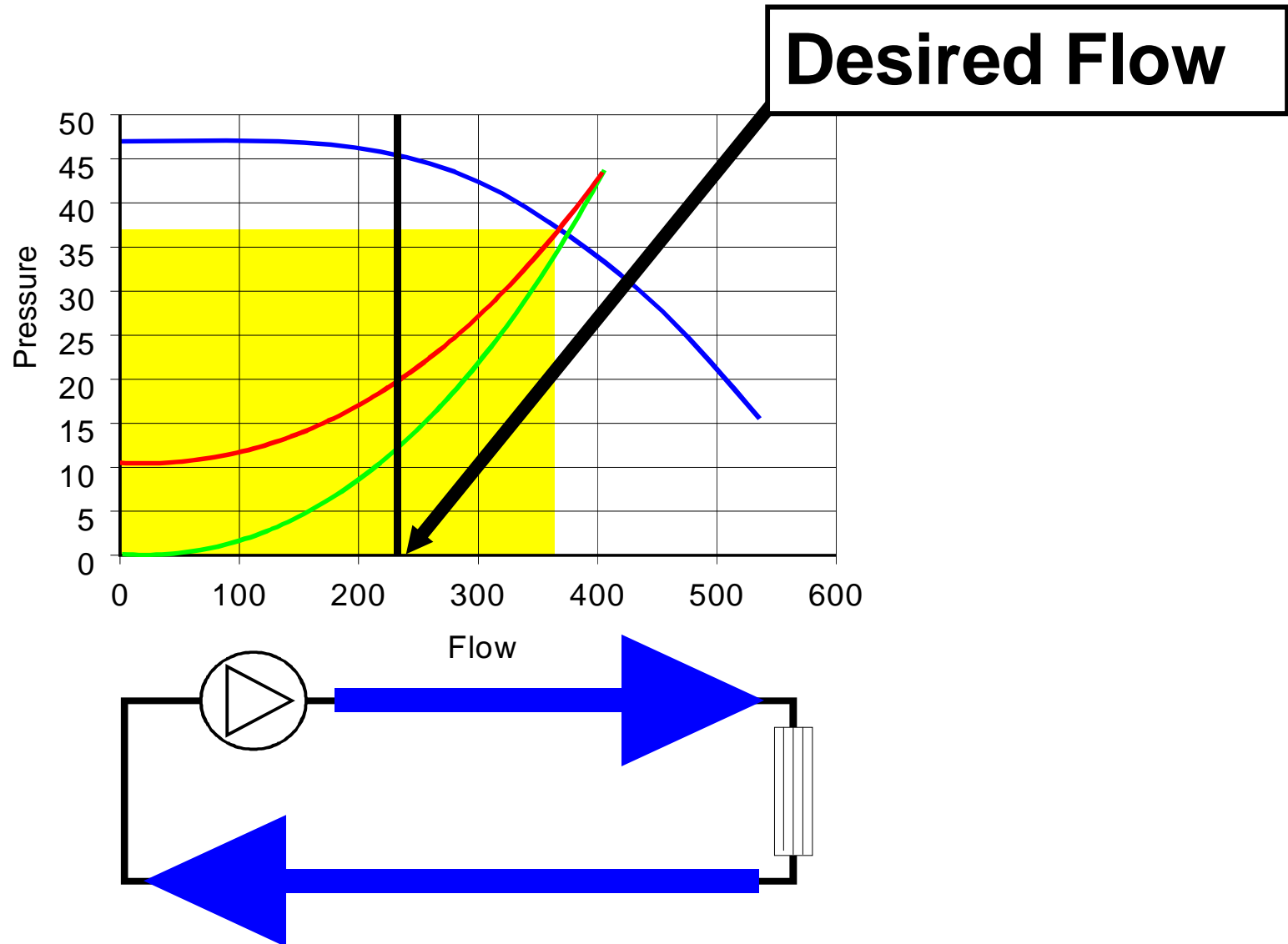


Energy Requirements

Power \propto Flow x Pressure

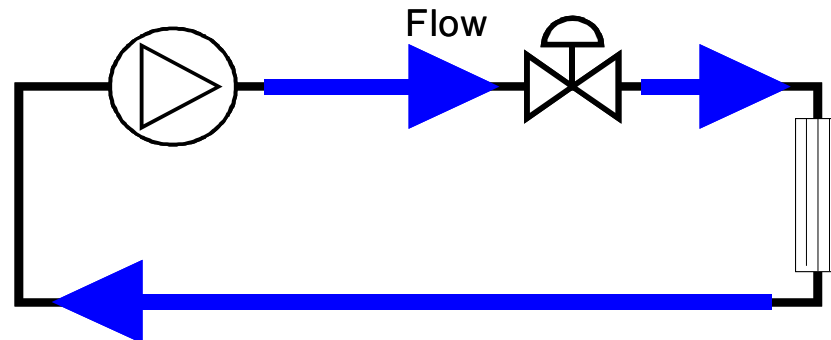
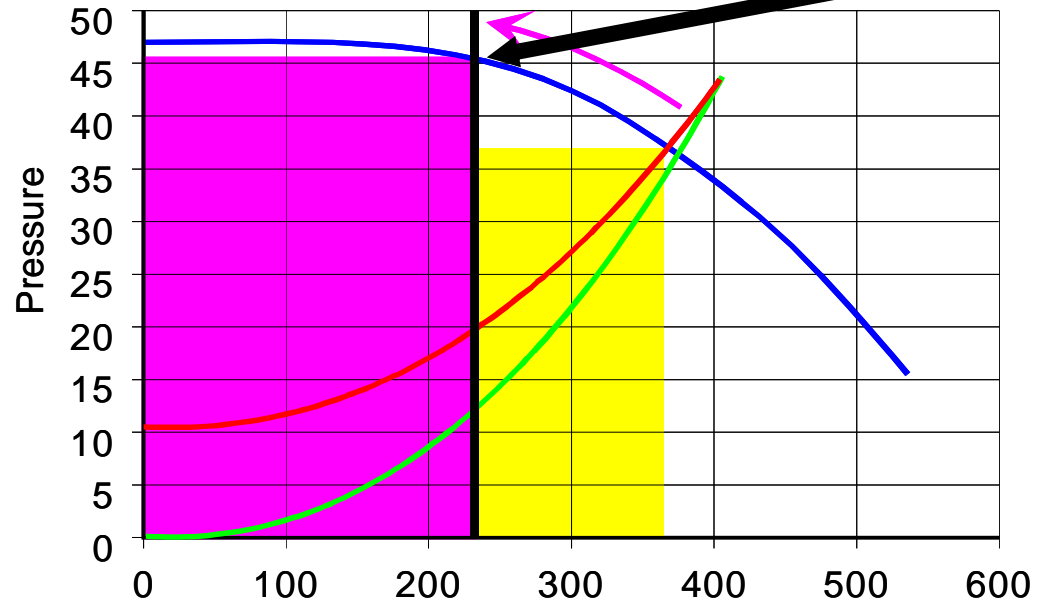


Energy Requirements

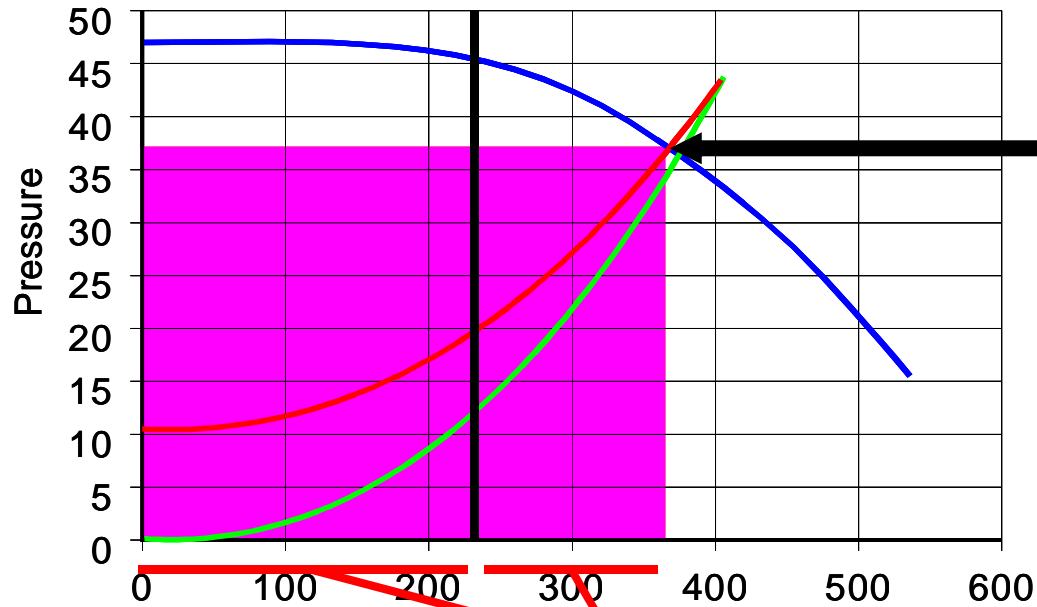


Energy Requirements Two-Way Valve (Throttling)

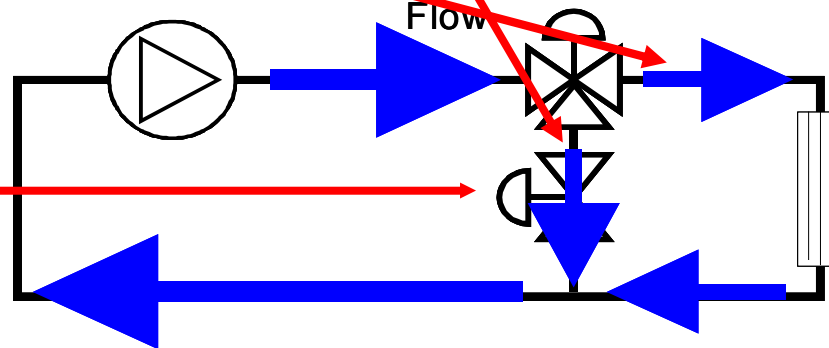
Power



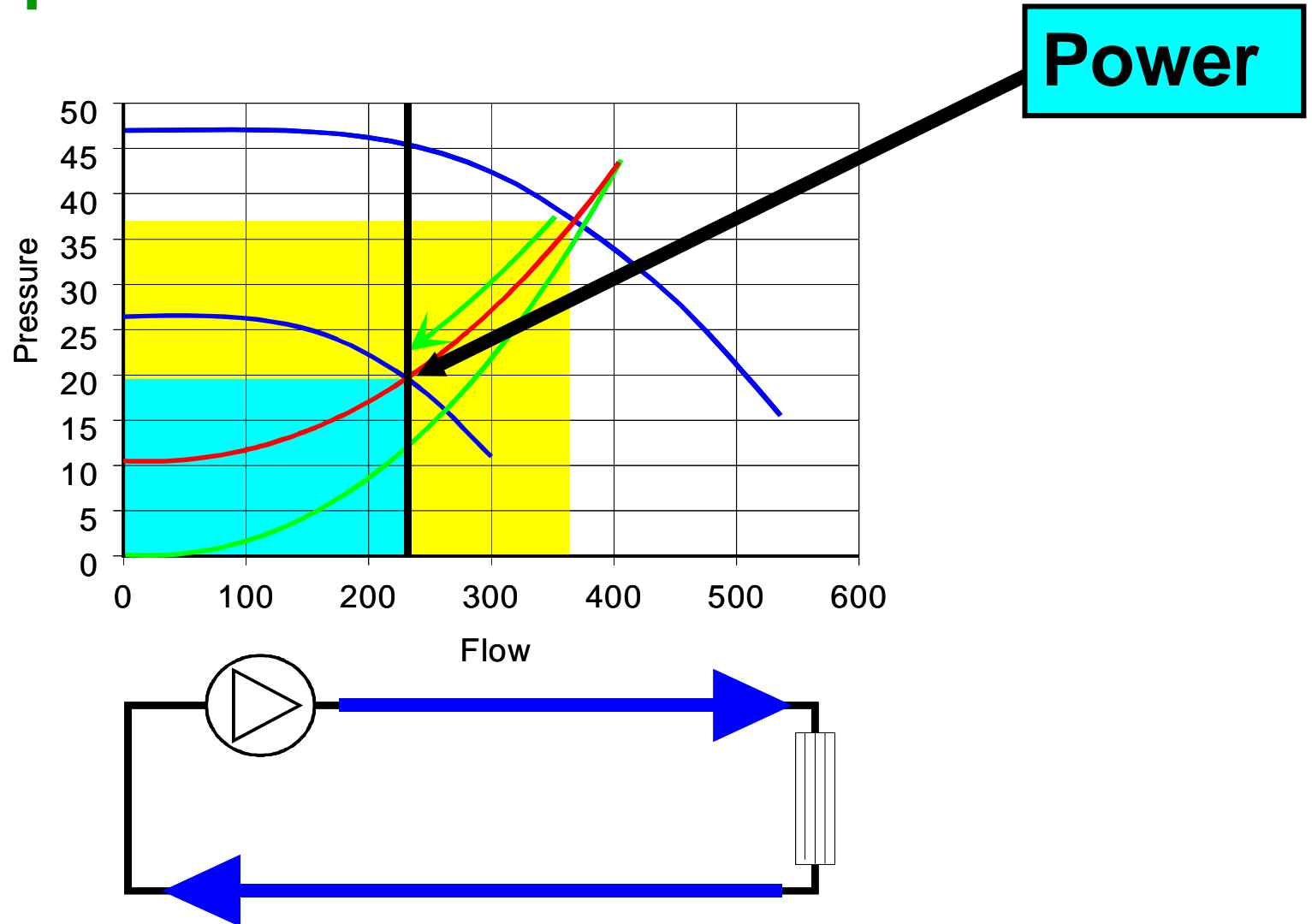
Energy Requirements Three-Way Valve (Bypass)



**Balancing
Valve**



Energy Requirements Adjustable Speed





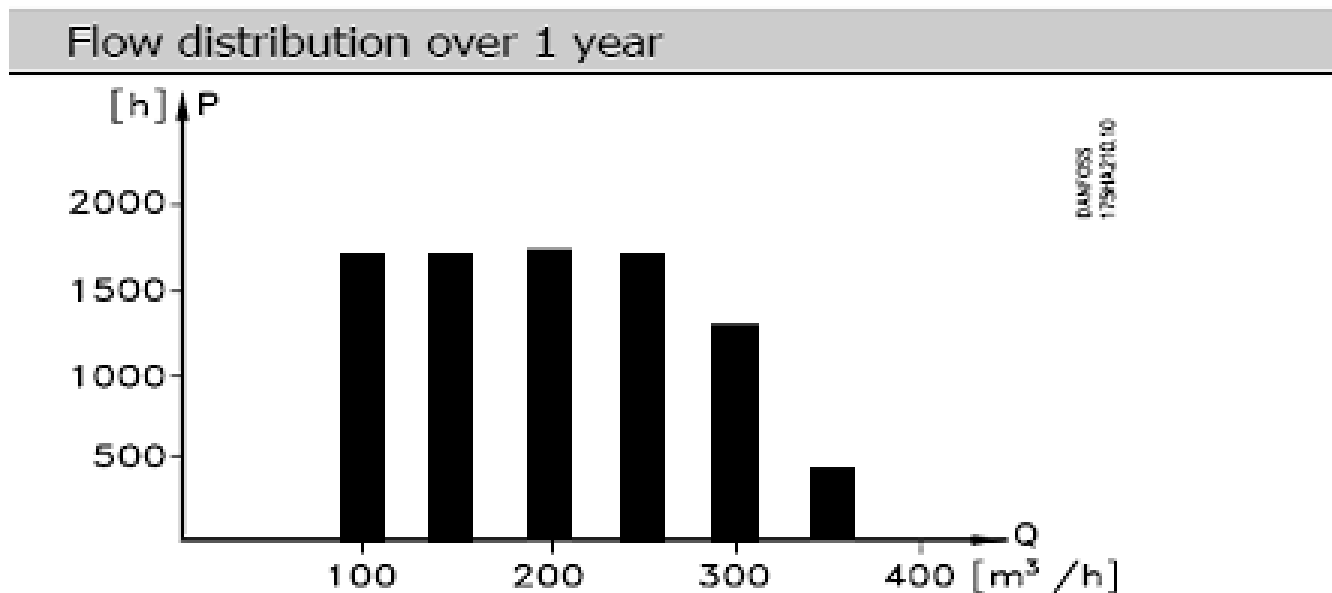
Energy Saving – calculation example

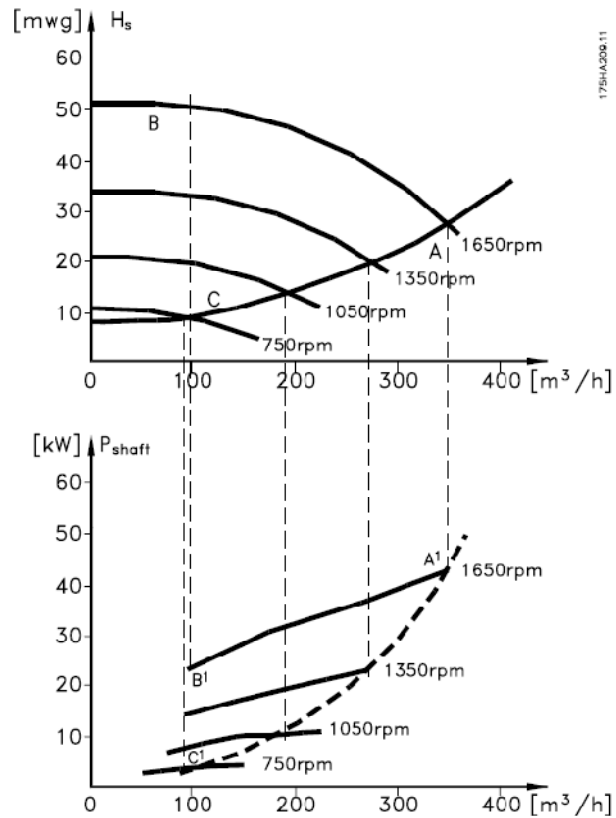
Adjustable Speed

The example below is calculated on the basis of pump characteristics obtained from a pump datasheet.

The result obtained shows energy savings in excess of 50% at the given flow distribution over a year.

The pay back period depends on the price per kwh and price of frequency converter. In this example it is less than a year when compared with valves and constant speed.





Energy Saving - calculation example Adjustable Speed

total energy saving = ca. 250.000 kWh

m ³ / h	Distribution		Valve regulation		Frequency converter control	
	%	Hours	Power	Consumption	Power	Consumption
		s	A ₁ - B ₁	kWh	A ₁ - C ₁	kWh
350	5	438	42,5	18.615	42,5	18.615
300	15	1314	38,5	50.589	29,0	38.106
250	20	1752	35,0	61.320	18,5	32.412
200	20	1752	31,5	55.188	11,5	20.148
150	20	1752	28,0	49.056	6,5	11.388
100	20	1752	23,0	40.296	3,5	6.132
Σ	100	8760		275.064		26.801



Energy Saving – proven references Adjustable Speed

Pumping station:

- old solution
 - 4 pumps with 315 kW motors supplied from 6kV voltage
 - control of capacity – valves
- 1 step of modernisation
 - analysis of really water consumption
 - optimal pump selection
 - decision >>> VSD to control of capacity dependent on actual water consumption
- 2 step of modernisation
 - realisation – 4 pumps with 132 kW motors
 - all pumps controlled with VSD
 - completely new switching station
- results
 - significant reduction of energy consumption – ca 20-30kPLN/month
 - more flexibility of pumping system to adapt to water changes of water consumption
 - estimated pay back time (only energy saving) – ca 2 years (comparing to all investment costs)



Energy Saving – proven applications Adjustable Speed



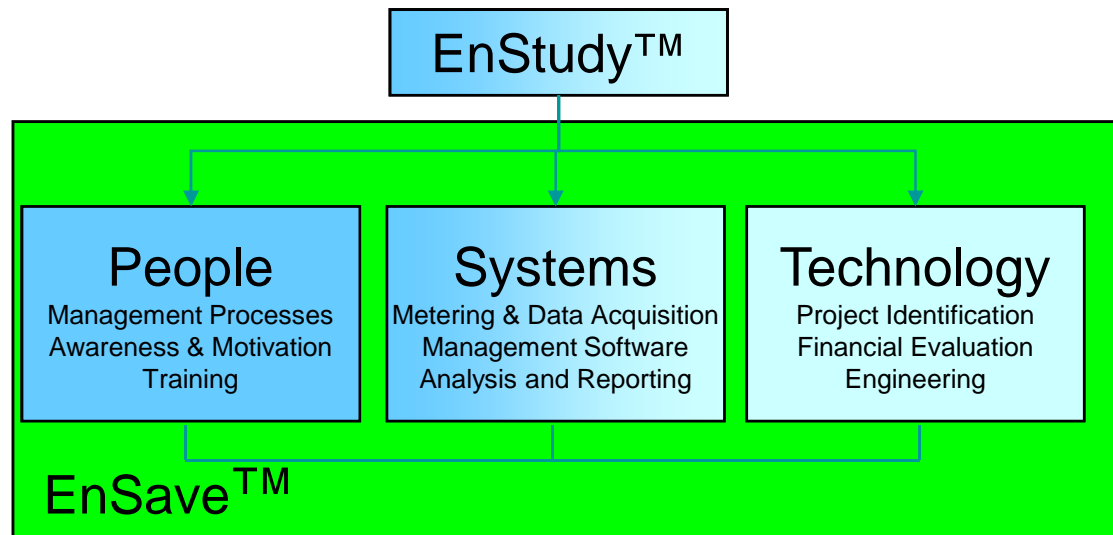
Danfoss Solution A/S – The EnSave™ Project Kasztelan Brewery - Sierpc

A combination of

- ❖ Benchmarking
- ❖ Plant Audits
- ❖ Change Mgt,
- ❖ Technical Solutions
- ❖ Utility Mgt. System
- ❖ Turn-key Solution
- ❖ Perf. Contract

Result:

Guaranteed utility cost savings which **impact your bottom line**



EnSave™Pro

■ **Pay-for-Performance / No Cure – No Pay!**



Total Utility Reduction ~ 24%

- Electricity ~ 26%
- Fuel ~ 27%
- Water ~ 28%
- CO2 ~ 0%

- Official Project period: Oct. 1 2003 – Sep. 30, 2007
- Project content: 13 technical installations, M&T and MONTAGE™
- Guaranteed savings, Start till May 2005: 322,000 €
- Achieved Savings: 435,000 €



EnSave projects

RECOMMENDATION	ANNUAL SAVINGS					
	Elec. (kWh)	Fuel (kWh)	Water (m³)	Effluent (m³)	CO ₂ (kg)	Cost (€)
1. Improve Control of SG Compressor	25.500	0	0	0	0	1.599
2. Apply VLT to Main Air Compressor	80.300	0	0	0	0	5.035
3. Oxygen Trim of 4 No. Boilers	102.300	1.070.800	0	0	0	25.474
4. VLT Control of HPHW Pumps	76.100	0	0	0	0	4.771
5. Improve Thermal Insulation	0	803.500	0	0	0	14.302
6. VLT Control of Yeast Room Glycol Pump	20.100	0	0	0	0	1.260
7. Implement Floating Head Pressure Control	92.700	0	0	0	0	5.812
8. Apply Temporary VLT's to Cooling Tower	91.000	0	0	0	0	5.706
9. VLT Control of Drying Kilns' Heater Battery Pumps	167.800	0	0	0	0	10.521
10. VLT's for Maltings' Aspirators	127.200	0	0	0	0	7.975
11. VLT's and Improved Control for Malt Drying Kilns	360.000	3.609.000	0	0	0	86.812
12. VLT's and Improved Control for Germination Boxes	31.100	0	0	0	0	1.950
13. Monitoring and Targeting	263.000	1.690.000	13.600	13.600	31.900	64.673
TOTAL	1.437.100	7.173.300	13.600	13.600	31.900	235.897

•report from Sept.2006



..... more and more other applications
where customers are satisfied
significant energy saving in result of
VSD application

Thank you for your advance

We invite you to solve your problems