BME Dept. of Hydrodynamic Systems

Volumetric Pumps and Compressors BMEGEVGAG04
Sample Test Questions

Lecturer: Csaba Hős, csaba.hos@hds.bme.hu
15th November 2017

Introduction

1. Explain the differences between turbompumps and positive displacement pumps! (Build-up, working principle, $Q(\Delta p)$ curves.) Give an example of both types.

2. Define specific speed! Explain the quantities in the equation, give their units!

3. We need a pump with flow rate 500 liter/min and 60 m head. The driving motor revolution number is 3000 rpm. What type should we use? Why?

4. We need a pump with flow rate 500 liter/min and 60 bar pressure difference. The driving motor revolution number is 3000 rpm. What type should we use? Why?

5. A pump delivers 20 liter/min fow rate at 60 bar pressure difference. Give an estimation of the driving motor's power!

General characteristics of PDPs

1. Give the basic performance equations for positive displacement *pumps*! (flow rate, pressure difference, useful and input power, efficiencies.) Explain all quantities!

2. Give the basic performance equations for positive displacement *motors*! (flow rate, pressure difference, useful and input power, efficiencies.) Explain all quantities!

3. Plot the theoretical and real performance curves of a positive displacement pump for three revolution numbers $n_1 < n_2 < n_3$.

4. Plot the theoretical and real performance curves of a positive displacement motor for three revolution numbers $n_1 < n_2 < n_3$.

5. A single-piston pump delivers 7 liter/min average flow rate at 120 rpm. The piston diameter is 30 mm. Find the geometric displacement (V_g).

6. A triplex pump (piston pump with three pistons) delivers 25 liter/min average flow rate at 120 rpm. The piston diameter is 30 mm. Find the geometric displacement (V_g).

7. We have to provide $M = 120$ Nm torque at 1500 rpm revolution number with a hydraulic motor. The allowed maximum pressure is 300 bar, the pump is driven at 1500 rpm. Find a suitable motor and pump if the possible sizes (V_g) are $5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100\,cm^3$ for both the pump and the motor.

8. We have a hydraulic cylinder that requires 300 bar pressure and 90 liter/min flow rate. The pump is of size $V_g = 32\,cm^3$ driven at 3000 rpm, the pressure relief valve is set to 350 bar. The operating point is set by a throttle valve. Based on the efficiency of the circuit, should the valve be connected in series or parallel? Make a sketch of both circuits and show the flow rates and pressure differences for all elements!

Reciprocating and rotary pumps

1. What kind of reciprocating pumps do you know? Give some details on them.
2. What kind of rotary pumps do you know? Give some details on them.

Pressure relief valves (PRV)

1. Explain the ideal and real performance curve of a PRV (equations are not needed). Explain its behaviour on the different segments.
2. What are the static and dynamic errors associated with a PRV?
3. Draw a sketch of a direct spring operated pressure relief valve. Explain how it works.
4. Draw a sketch of a pilot operated pressure relief valve. Explain how it works.

Piston pumps

1. Draw the sketch of a single-acting piston pump. Explain how it works.
2. Show the flow rate diagram of a single-acting pump and derive the formula for mean and maximum flow rate!
3. Show the flow rate diagram of a duplex pump and derive the formula for mean and maximum flow rate!
4. How does the pressure pulsation level vary with increasing piston numbers? Explain with the help of flow rate diagrams!

Pulsation damper

1. Show the following diagrams qualitatively properly for a single-acting pump: pump flow rate, pulsation damper flow rate, volume change in the pulsation damper and gas pressure variation. The diagrams should be located below each other with the same time scale.
2. Choose a pulsation damper for the following pump: $V_{stroke} = 1$ liter, $\nu = 55.1\%$ the pre-charge pressure is 70% of the system pressure.

Simple hydraulic circuits

1. What is a hydraulic aggregate? Make a sketch and plot its performance curve!
2. A hydraulic aggregate drives a motor. The required torque and revolution number (that is, the motor pressure drop and flow rate) are adjusted via a *parallel* throttle valve. Make a sketch of the system and plot the flow rates, pressure differences, useful power and the different losses in the same figure!
3. A hydraulic aggregate drives a motor. The required torque and revolution number (that is, the motor pressure drop and flow rate) are adjusted via a throttle valve connected in *series*. Make a sketch of the system and plot the flow rates, pressure differences, useful power and the different losses in the same figure!

Piston compressors

1. Draw a sketch of a piston diagram and depict the cycle in the p_V diagram. Explain the different segments of the cycle.
2. How does the dead volume effect the flow rate of a piston compressor?
3. Why is it advantageous to split the compression cycle into two (or more) separate stages? Explain in $p - V$ diagram.
4. We have to compress gas from $p_1 = 1$ bar (absolute) to $p_2 = 8$ bars in two stages. Find the optimal middle-pressure p_x.