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METHOD OF SUM OF POWER LOSSES AS A WAY FOR DETERMINING THE K_I COEFFICIENTS OF ENERGY LOSSES IN HYDRAULIC MOTOR

A. Maczyszyn, Ph. D.
Gdańsk University of Technology, Poland

ABSTRACT

This paper shows application of the method of sum of power losses to determining energy losses which occur in hydraulic rotary motor in situation when not all laboratory data are at one's disposal or when no use is made of data contained in catalogue charts. The method makes it possible to determine the coefficients ,k_i , of energy losses occurring in the motor. The method of sum of power losses is based on the approach proposed by Z. Paszota, in the papers [3 ÷ 9]. It consists in adding power flow of energy losses occurring in the motor to power flow output and comparing the sum to the power flow input. Application of the method is exemplified by using a A6VM hydraulic motor.

Keywords: hydrostatic drive, power of energy losses, hydraulic rotary motor

INTRODUCTION

Since not long ago a diagram proposed by prof. Paszota[7], which presents a power increase in hydraulic motor oposite to power flow direction in the motor, has been available in the subject –matter literature. The diagram clearly describes dependences of particular power losses occurring in hydraulic motor and relations between them.

According to Fig. 1 the power losses and energy efficiency depends on output parameters of the motor, i.e. its angular velocity ω_M and torque M_M. They are quantities independent on the motor itself and the system within the motor operation field $0 \le \omega_M < \omega_{Mmax}$, $0 \le M_M < M_{Mmax}$ [3, 4]. Whereas the motor input parameters, i.e. the motor input flow rate Q_M (motor absorbing capacity) and the pressure decrease Δ_{pM} in the motor are dependent quantities [7]. The Paszota's approach makes it possible to present the total efficiency η_M of the hydraulic motor, i.e. the ratio of the effective motor shaft power P_{Mu}, demanded from the side of the machine driven by the motor and the power P_{Mc}, consumed by the motor, in function of the motor shaft torque M_M, shaft rotational speed n_M and working liquid viscosity ν:

$$\eta_M = \frac{P_{Mu}}{P_{Mc}} = f(M_M, n_M, \nu)$$

In the publication [2], which initiated the forming of a library of the coefficients k_i of energy losses occurring in various types of pumps and hydraulic motors, it was proposed the method of sum of power losses, which allows to determine the coefficients ki on the basis of knowledge of particular power losses occurring in a given machine.

In order to prepare energy balance for a hydraulic motor used in a hydrostatic drive system, power losses should be (acc. Fig.1) added to motor power output because these are power output parameters which decide on power of particular losses [7]. Such approach made it possible to develop the method of sum of powers [2], which allows for determining the coefficients k_i, of energy losses occurring in hydraulic motor.

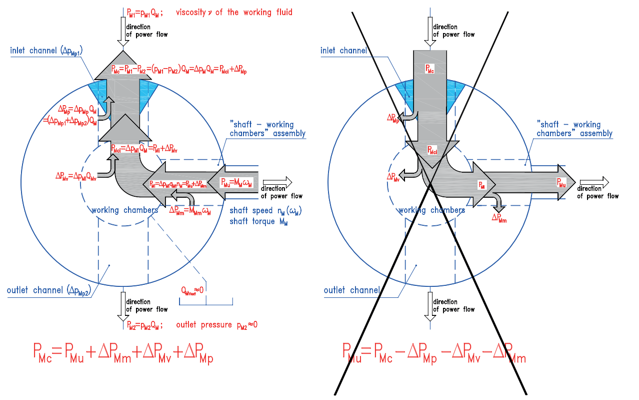

Fig.1 Diagram of power increase in a hydraulic motor opposite to the direction of power flow, replacing the Sankey's diagram of power decrease in the direction of power flow [7]

A6VM HYDRAULIC MOTOR

In the A6VM Bosch Rexroth axial piston motor, shown in Fig. 2, whose basic working parameters are given in Tab. 1, the pistons are placed axially in the rotating cylinder block. Axial piston motors are usually fitted with an uneven number of pistons. During rotation of the cylinder block 6, the pistons 7 located in it, forming - together with the cylinders - the working chamber, connect one by one with the inflow and outflow space of the hydraulic motor through the holes in the face space of the cylinder block 6. At the motion of the plunger to the left the working space increases, connects to the inflow (pressure) space and become filled with liquid. At the motion of the plunger to the right the working space decreases, the liquid is discharged into the outflow (low-pressure) space. During operation of the motor a part of its chambers is filled with the working liquid whereas from the other chambers the liquid is discharged into the outflow conduit. To the motor was applied the spherical distributor 5 in which the spaces are connected to the channels in the motor casing and the inflow and outflow holes. In the motor, mainly in the distributor 5, leakages from the high- pressure leg into the low-pressure leg take place.

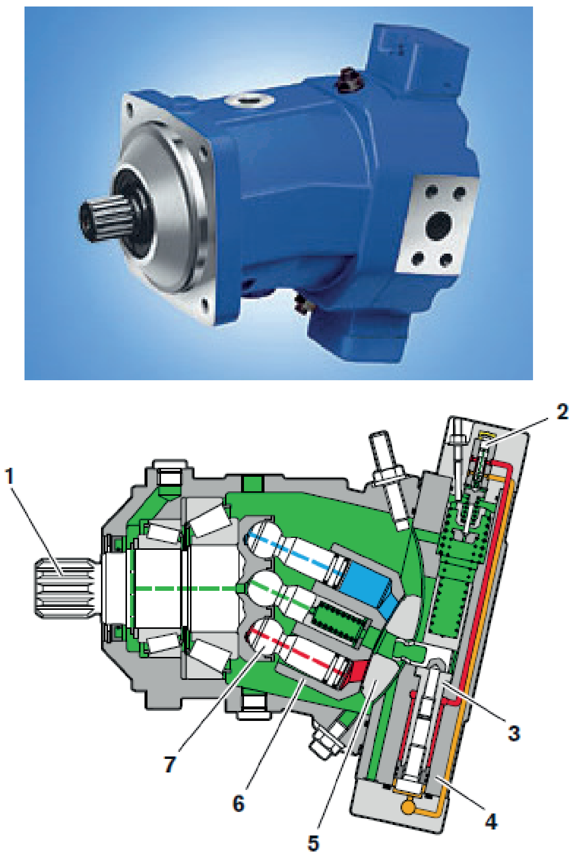

Fig. 2 Overall view [12] and cross-section [9] of the A6VM axial piston motor of a variable absorbing capacity per rotation, fitted with the tilting cylinder block, produced by Bosch Rexroth:
1 – driving shaft, 2 – control piston, 3 –piston stroke control unit,
4 – casing in which the control piston is placed, 5 – distributor,
6 – cylider block, 7 – piston (plunger)

Tab. 1 The basic parameters of A6VM motor [11]

	q_{Mt} [m³/rotation]	n_{Mt} [s⁻¹]	ν_n [mm²s⁻¹]	p_n [MPa]	M_{Mt} [Nm]	P_{Mc} [kW]
A6VM55	$54{,}8\cdot10^{-6}$	70,0	22	40	348,9	153,4

METHOD OF SUM OF POWERS

For determining the coefficients, k_i, of energy losses in the A6VM55 motor the use was made of the tables containing results of the laboratory tests [11] in which the following quantities are given: the pressure decrease Δ_{pM} in the motor; the rotational speed n_M of the motor, defined as the ratio of the current rotational speed n_M and the theoretical (maximum) rotational speed n_{Mt}; the absorbing capacity per shaft rotation, q_{Mt}, of the motor as well as the coefficient, b_M, of change of motor absorbing capacity defined as the ratio of the variable absorbing capacity per shaft rotation, q_{Mgv}, and that theoretical per shaft rotation, q_{Mt}, the total efficiency η_M; the "mechanical – hydraulical" efficiency η_{mh}; the volumetric efficiency η_{Mv}. The measurements were carried out at the constant viscosity of the liquid equal to $\nu = 22mm^2s^{-1}$.

In compliance with Fig. 1 the working liquid power P_{Mc} consumed by the motor is a sum of the effective power P_{Mu} (demanded on the motor shaft by a device driven by it), the power, ΔP_{Mm}, of mechanical losses in the "shaft – working chambers" constructional unit, the power, ΔP_{Mv}, of volumetric losses in working chambers and the power, ΔP_{Mp}, of pressure losses in the motor channels:

$$P_{Mc} = P_{Mu} + \Delta P_{Mm} + \Delta P_{Mv} + \Delta P_{Mp}$$

The above given equation became the starting point for developing the algorithm presented in the publication [2]. By calculating particular components of power losses within the motor it was possible to determine losses occurring in the machine and, basing on them, to calculate the loss coefficients k_i, precisely.

THE POWER P_{MC} CONSUMED BY THE MOTOR

The power P_{Mc} absorbed by the hydraulic motor from the liquid, results from the product of the pressure decrease, Δp_M, in the motor and its absorbing capacity Q_M:

$$P_{Mc} = \Delta p_M \cdot Q_M$$

The motor absorbing capacity Q_M demanded by the motor from the side of the liquid driving it, must be greater than the rate equal to the product q_{Mt} n_M (resulting from the theoretical absorbing capacity per shaft rotation, q_{Mt}, and the shaft motor rotational speed n_M, demanded by a device driven by the motor) because of occurrence of volumetric losses in working chambers of the motor. The absorbing capacity Q_M is hence equal to the sum of of the rate q_{Mt} n_M and the volumetric losses rate Q_{Mv}:

$$Q_M = q_{Mt} \cdot n_M + Q_{Mv}$$

In order to know quantity of the absorbing capacity, Q_M, of the motor of the variable absorbing capacity per shaft rotation, q_{Mgv}, can be used the formula representing the quotient of the product of the absorbing capacity per shaft rotation, q_{Mgv}, and the motor shaft rotational speed n_M over the motor volumetric efficiency η_{Mv}:

$$Q_M = \frac{q_{Mgv} n_M}{\eta_{Mv}} = \frac{q_{Mt} b_M n_M}{\eta_{Mv}}$$

Knowing the pressure decrease, Δ_{pM}, in the motor and its absorbing capacity Q_M one can calculate the power, P_{Mc}, of the working liquid consumed by the motor.

THE EFFECTIVE POWER P_{MU} OF THE MOTOR

The motor effective power P_{Mu} can be calculated by using the transformed formula for the total efficiency η_M of hydraulic motor, as follows :

$$P_{Mu} = \eta_M P_{Mc}$$

From mathematical point of view the above given relationship is correct though it represents rather Sankey's approach; however it results from the necessity of determining the quantity of the effective power P_{Mu} in which quantity of the motor shaft torque M_M is contained.

THE POWER ΔP_{MP} OF PRESSURE LOSSES IN THE MOTOR

The power ΔP_{Mp} of pressure losses in hydraulic motor is the sum of the power ΔP_{Mp1} of pressure losses in inflow channel and the power ΔP_{Mp2} of pressure losses in outflow channel of the motor, as follows:

$$\Delta P_{Mp} = \Delta P_{Mp1} + \Delta P_{Mp2}$$

In the general case the power ΔP_{Mp} of pressure losses is equal to the product of the pressure loss Δp_{Mp} and the liquid flow rate Q_M:

$$\Delta P_{Mp} = \Delta p_{Mp} \cdot Q_M$$

According to the above given relation , the formula which describes the power ΔP_{Mp} of pressure losses in hydraulic motor takes the following form:

$$\Delta P_{Mp} = \Delta P_{Mp1} + \Delta P_{Mp2} = \Delta p_{Mp1} Q_M + \Delta p_{Mp2} Q_{M2}$$

In rotary motor the liquid flow rate Q_{M2} in its outflow channel is practically equal to that in its inflow channel (i.e. the motor absorbing capacity Q_M): $Q_{M2} = Q_M$, therefore it is possible to write that the power ΔP_{Mp} of pressure losses in the motor is equal to:

$$\Delta P_{Mp} = (\Delta p_{Mp1} + \Delta p_{Mp2}) Q_M = \Delta p_{Mp} \cdot Q_M$$

In order to determine the pressure losses, Δp_{Mp}, in motor channels (flow drag and losses in distributor) the use was made of the laboratory data given by J. Koralewski in [1], and the quantity of the pressure losses Δp_{Mp} in motor channels was assumed equal to that of the losses occurring in the A7V.58. DR.1.R.P.F.00 pump which is a twin unit for the A6VM motor. It results also from the fact that the publication [11] in which the laboratory data are presented, deals with an entire series of types of the motors whose absorbing capacity per shaft rotation is contained within the interval: $28{,}1 \cdot 10^{-6} \div 200 \cdot 10^{-6}$ m^3/rotation, and their rotational speed changes in the range: 88,33 ÷ 45,83 rotation/s.

The pressure losses Δp_{Pp} in channels of the A7V.58. DR.1.R.P.F.00 pump reached, at the viscosity $\nu = 22\ mm^2s^{-1}$ used for testing the hydraulic motor, the following value:

$$\Delta p_{Pp} = k_3\, p_n \left(\frac{Q_P}{Q_{Pt}}\right)^{a_{Qp}} \left(\frac{\nu}{\nu_n}\right)^{a_{\nu p}} = 0{,}0012 \cdot 32 \cdot 10^6 \cdot \left(\frac{1472{,}5 \cdot 10^{-6}}{1472{,}5 \cdot 10^{-6}}\right)^{1,76} \cdot \left(\frac{22}{35}\right)^{0,26}$$

$$\Delta p_{Pp|Q_P = Q_{Pt};\nu} = 0{,}034 \left[MPa\right]$$

Therefore the pressure losses Δp_{Mp} in channels of the A6VM55 motor will be in compliance with the following formula:

$$\Delta p_{Mp} = k_8\, p_n \left(\frac{Q_M}{Q_{Pt}}\right)^{a_{Qp}} \left(\frac{\nu}{\nu_n}\right)^{a_{\nu p}}$$

and, due to the fact that the tests of the A6VM55 motor were carried out at one constant value of the hydraulic oil viscosity $\nu = 22\ mm^2s^{-1}$, the expression $\left(\frac{\nu}{\nu_n}\right)^{a_{\nu p}}$ was assumed equal to 1. The exponent a_{Qp} of the influence of the liquid flow rate Q_M in channels on the pressure losses Δp_{Mp} was assumed equal to 1,78; based on the tests [1] which were performed at hydraulic oil viscosity varying in the range from 14,53 mm^2s^{-1} to 91,16 mm^2s^{-1}. With taking into account the change of the motor speed from n_{Pt} to n_{Mt}, and the motor absorbing capacity the following was reached:

$$\Delta p_{Mp} = \Delta p_{Pp|Q_P = Q_{Pt};\nu} \left(\frac{Q_M}{Q_{Pt}}\right)^{1,78}$$

$$\Delta p_{Mp} = 0{,}034\left[MPa\right] \cdot \left(\frac{54{,}8 \cdot 10^{-6}\left[m^3/obr\right] \cdot 70\left[s^{-1}\right]}{58 \cdot 10^{-6}\left[m^3/obr\right] \cdot 25\left[s^{-1}\right]}\right)^{1,78} = 0{,}192\left[MPa\right]$$

The coefficient, k_8, of pressure losses in internal channels of the A6VM55hydraulic motor at the flow rate equal to the theoretical capacity Q_{Pt} of the pump, in relation to the nominal pressure p_n of the system, reached the following value:

$$k_8 = \frac{\Delta p_{Mp|Q_M = Q_{Pt},\nu}}{p_{Mn}} = \frac{0{,}192\left[MPa\right]}{40\left[MPa\right]} = 0{,}005$$

Knowing the value of the coefficient k_8 one can determine value of the pressure losses Δp_{Mp} in motor channels by using the formula:

$$\Delta p_{Mp} = k_8\, p_n \left(\frac{Q_M}{Q_{Pt}}\right)^{a_{Qp}} \left(\frac{\nu}{\nu_n}\right)^{a_{\nu p}}$$

Values of the pressure losses Δp_{Mp} in A6VM55 motor channels, determined this way, are presented in Fig. 3 in function of the motor absorbing capacity Q_M.

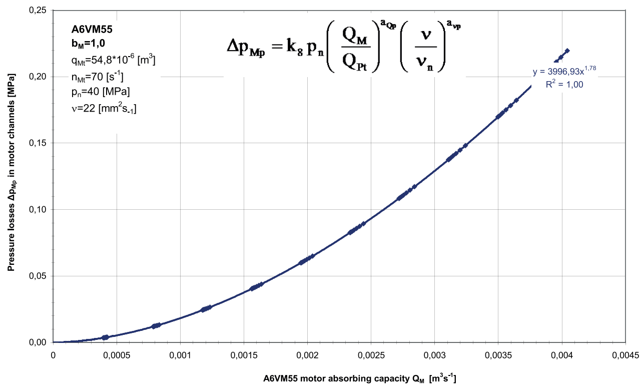

Fig. 3 Pressure losses Δp_{Mp} in A6VM55 motor channels in function of the motor absorbing capacity Q_M

THE POWER ΔPMV OF VOLUMETRIC LOSSES IN THE MOTOR

The power ΔP_{Mv} of volumetric losses in the motor are equal to the product of the volumetric losses rate Q_{Mv} (mainly the rate of internal leakages between the working inflow and outflow chambers) and the pressure decrease Δp_{Mi} induced between the pressure p_{M1i} in inflow chambers of the motor and the pressure p_{M2i} in its outflow chambers:

$$\Delta P_{Mv} = Q_{Mv} \cdot \Delta p_{Mi} = Q_{Mv}\,(p_{M1i} - p_{M2i}).$$

The pressure decrease Δp_{Mi} induced in motor working chambers together with the pressure losses Δp_{Mp} in motor chambers provides the pressure decrease Δp_M in the motor, as follows:

$$\Delta p_M = \Delta p_{Mi} + \Delta p_{Mp}.$$

On transformation of the expression , one is able to determine the pressure decrease Δp_{Mi} induced in motor working chambers:

$$\Delta p_{Mi} = \Delta p_M - \Delta p_{Mp}.$$

To calculate the volumetric losses rate Q_{Mv} in motor working chambers one can make use of the following relation:

$$Q_{Mv} = Q_M - b_M q_{Mt} n_{Mt}.$$

For determining the coefficient k_9 of the volumetric losses Q_{Mv} in hydraulic motor one can make use of the formula:

$$k_9 = \frac{Q_{Mv|\Delta p_{Mi}=p_n}}{Q_{Pt}}$$

applying appropriate values read from Fig. 4.

$$k_9 = \frac{0{,}000206\left[m^3 s^{-1}\right]}{0{,}0038\left[m^3 s^{-1}\right]} = 0{,}054[-]$$

Knowing value of the pressure decrease Δp_{Mi} induced in motor working chambers as well as the volumetric losses rate Q_{Mv} in the motor, one can calculate values of the power ΔP_{Mv} of volumetric losses which occur in the motor.

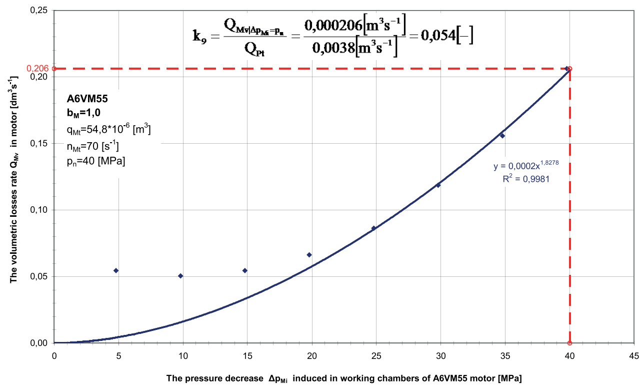

Fig. 4 The volumetric losses rate Q_{Mv} in working chambers of A6VM55 motor in function of the pressure decrease Δp_{Mi} induced in motor working chambers

Drawing the relationship of the volumetric losses rate Q_{Mv} in motor working chambers in function of the pressure decrease Δp_{Mi} in motor working chambers at constant values of the shaft rotational speed nM (Fig. 5), one obtains the data which allow to determine the exponent a_{pv} as shown in Fig. 6.

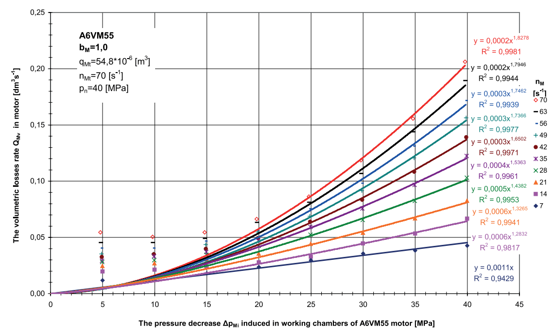

Fig. 5 The volumetric losses rate Q_{Mv} in working chambers of A6VM55 motor in function of the pressure decrease Δp_{Mi} induced in motor working chambers at constant values of the motor shaft rotational speed nM

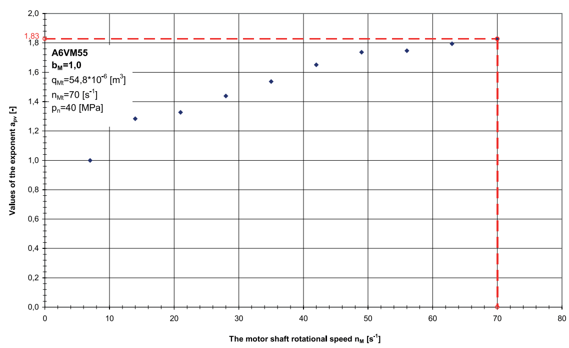

Fig. 6 Values of the exponent a_{pv} (of the power function which describes the relation between the volumetric losses rate Q_{Mv} and the pressure decrease Δp_{Mi} induced in hydraulic motor working chambers) in function of the shaft rotational speed nM of A5VM55 motor

THE POWER ΔPMM OF MECHANICAL LOSSES IN THE "SHAFT- WORKING CHAMBERS" CONSTRUCTIONAL UNIT OF THE MOTOR

In compliance with the equation being the basis for the developed algorithm , the power P_{Mc} of working liquid consumed by motor is equal to the sum of the effective power P_{Mu} and the power of losses which occur in the motor. The power ΔP_{Mm} of mechanical losses in the "shaft- working chambers" constructional unit can be hence calculated, on transformation, as follows:

$$\Delta P_{Mm} = P_{Mc} - P_{Mu} - \Delta P_{Mv} - \Delta P_{Mp}.$$

The mechanical losses power ΔP_{Mm} in hydraulic motor is that associated with mechanical friction forces and inertia forces of moving elements in the constructional unit which transmits mechanical power from moving elements in working chambers to rotational motor shaft.

The mechanical losses power ΔP_{Mm} is the product of the mechanical losses torque M_{Mm} and motor shaft angular velocity ω_M:

$$\Delta P_{Mm} = M_{Mm} \cdot \omega M.$$

Therefore the mechanical losses torque M_{Mm} determined from the above given relation, is equal to:

$$M_{Mm} = \frac{\Delta P_{Mm}}{\omega_M}$$

The torque M_{Mi} induced in motor working chambers is equal to the sum of the torque M_M loading the motor shaft and the mechanical losses torque M_{Mm}:

$$M_{Mi} = M_M + M_{Mm}.$$

The torque M_{Mi} induced in motor working chambers can be also calculated from the relation :

$$\frac{q_{Mt}\Delta p_{Mi}}{2\pi} = M_{Mi}$$

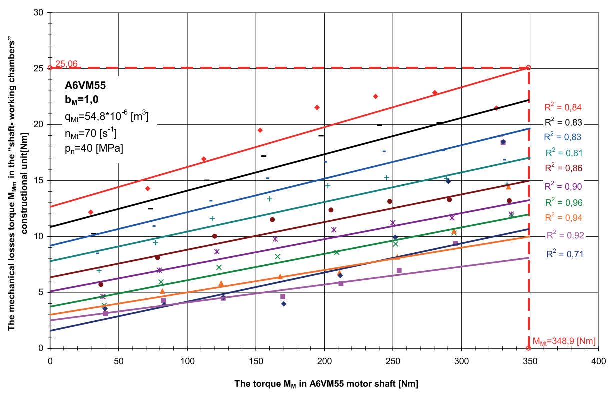

Fig. 7 The mechanical losses torque M_{Mm} in the "shaft- working chambers" constructional unit in function of the torque M_M in A6VM55 motor shaft

Value of the mechanical losses torque MMm in the motor of the geometrical (changeable) absorbing capacity q_{Mgv} per shaft rotation was calculated in compliance with the relations given by Paszota Z. in [5]:

$$M_{Mm|M_M,n_M,b_M,v} = \left(k_{7.1.1} + k_{7.1.2}\frac{n_M}{n_{Mt}}b_M\right)M_{Mt}\left(\frac{v}{v_n}\right)^{a_{vm}} + k_{7.2}M_M =$$

$$= \left(k_{7.1.1} + k_{7.1.2}\frac{n_M}{n_{Mt}}b_M\right)\frac{q_{Mt}p_n}{2\pi}\left(\frac{v}{v_n}\right)^{a_{vm}} + k_{7.2}M_M$$

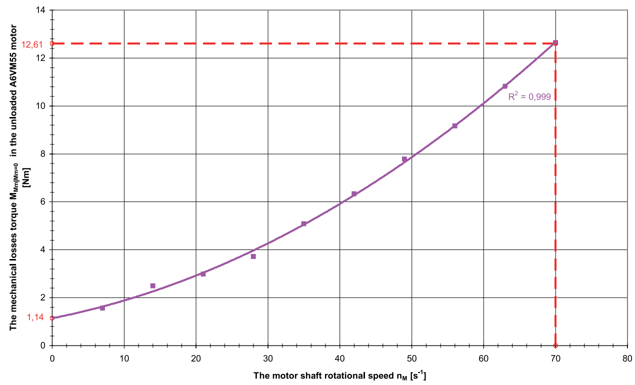

Fig. 8. The mechanical losses torque $M_{Mm|Mm=0}$ in the unloaded motor (M_M =0) in function of the rotational speed n_M of A6VM55 motor shaft

With taking into account constant hydraulic oil viscosity, the segment $\left(\frac{v}{v_n}\right)^{a_{vm}}$ was assumed equal to 1; therefore the formula which describes the mechanical losses torque M_{Mm}, takes the following form:

$$M_{Mm|M_M,n_M,b_M,v} = \left(k_{7.1.1} + k_{7.1.2}\frac{n_M}{n_{Mt}}b_M\right)M_{Mt} + k_{7.2}M_M$$

The coefficient $k_{7.1.1}$ was calculated by using the relation :

$$k_{7.1.1} = \frac{M_{Mm|M_M=0,n_M=0,b_M=1,v_n}}{M_{Mt}} = \frac{M_{Mm|M_M=0,n_M=0,b_M=1,v_n}}{\frac{q_{Mt}p_n}{2\Pi}}$$

for which an appropriate value of the mechanical losses torque M_{Mm} was read from Fig. 8.

$$k_{7.1.1} = \frac{1{,}14[Nm]}{348{,}9[Nm]} = 0{,}003$$

The coefficient $k_{7.1.2}$ was calculated by using the relation :

$$k_{7.1.2} = \frac{M_{Mm|M_M=0,n_M=n_{Mt},b_M=1,v_n} - M_{Mm|M_M=0,n_M=0,b_M=1,v_n}}{M_{Mt}},$$

for which an appropriate value of the mechanical losses torque M_{Mm} was read from Fig. 8.

$$k_{7.1.2} = \frac{12{,}61[Nm] - 1{,}14[Nm]}{348{,}9[Nm]} = 0{,}033$$

The coefficient $k_{7.2}$ was calculated by using the relation:

$$k_{7.2} = \frac{M_{Mm|M_M=M_{Mt},n_M=n_{Mt},b_M=1,v_n} - M_{Mm|M_M=0,n_M=n_{Mt},b_M=1,v_n}}{M_{Mt}},$$

for which an appropriate value of the mechanical losses torque $M_{Mm|M_M=M_{Mt},n_M=n_{Mt},b_M=1,v_n}$ in the motor loaded by the theoretical torque M_{Mt} was read from Fig. 7, and an appropriate value of the mechanical losses torque $M_{Mm|M_M=0,n_M=n_{Mt},b_M=1,\nu_n}$ in the unloaded motor – from Fig. 8.

$$k_{7.2} = \frac{25{,}06[Nm] - 12{,}61[Nm]}{348{,}9[Nm]} = 0{,}036$$

The presented method of sum of powers made it possible to calculate the coefficients k_i of energy losses occurring in A6VM motor , whose values are given in Tab. 2.

THE ENERGY LOSSES COEFFICIENTS

Tab. 2 which contains values of the coefficients k_i of energy losses in A6VM55 motor, clearly provides information on quantity and proportion of particular losses occurring in the motor in question. Similar breakdowns of the losses coefficients k_i in the case of other displacement machines would largely contribute in improving work quality and its advance rate of designers dealing with hydrostatic drive systems.

Tab. 2. Breakdown of the coefficients k_i of energy losses which occur in A6VM55 motor

A6VM55		**ν=22 [mm^2s^{-1}]** **q_{Mt} = 54,8·10^{-6} [m^3]** **b_M≠const.** **n_{Mn} = 70 [s^{-1}]** **p_n = 40 [MPa]** **P_{Mc} =153,4 [kW]**
M_{Mm}	**$k_{7.1.1}$=**	0,003
	$k_{7.1.2}$=	0,033
	a_{vm}=	-
	$k_{7.2}$=	0,036
Q_{Mv}	**k_9=**	0,054
	a_{pv}=	1,83
	a_{vv}=	-
	a_{nv}=	-
Δp_{Mp}	**k_8=**	0,005
	a_{Qp}=	1,78
	a_{vp}=	-

The exponents a_{vm}, a_{vv} and a_{vp} which tell about the impact of the working liquid viscosity ν on particular types of losses (m – mechanical; v – volumetric, p – pressure) were omitted because the tests were performed only for one value of working liquid viscosity equal to 22 mm^2s^{-1}.

The coefficient $k_{7.1}$ of the mechanical losses torque M_{Mm} which is the sum of the coefficients $k_{7.1.1}$ and $k_{7.1.2}$, provides information on losses due to friction between structural elements (e.g. bearings) as well as on losses between liquid which fills the casing and the cylinder block, friction between the rotating cylinder block and the motionless distributor.

The coefficient $k_{7.2}$ of the mechanical losses torque M_{Mm} tells about quantity of the mechanical losses torque increase ΔM_{Mm} in the motor as a result of increase in load, i.e. the motor shaft torque M_M.

The coefficient k_8 of the pressure losses Δp_{Mp} tells about quantity of losses which occur in the internal channels and distributor of the machine. The losses result mainly from local pressure losses due to changes in direction and velocity of liquid flow.

Value of the exponent a_{Qp} tells about the impact of the liquid flow rate Q_M in channels on the pressure losses Δp_{Mp}.

Value of the exponent a_{pv} tells about the impact of the induced pressure decrease Δp_{Mi} in working chambers on the volumetric losses rate Q_{Mv}. Its value informs both about a character of working liquid flow and the impact of gap changes in the motor.

SUMMARY

In this paper has been presented the method of sum of powers, which can be used for determining the coefficients, k_i, of energy losses occurring in hydraulic motors in the situation when not all laboratory data are given at one's disposal or when no use is made of the data contained in catalogue charts. The energy losses coefficients k_i achieved this way make it possible to assess, from energy point of view, displacement machines by using the approach to losses, proposed by Paszota Z. in [3÷8].

The energy losses coefficients k_i were thought so as to obtain a relative value of particular losses in an element of hydrostatic system (in a pump, hydraulic motor, as well as conduits and a motor speed throttle control unit). They make it possible to assess proportion and quantity of losses and value of element power efficiency (volumetric, pressure and mechanical one) resulting from losses which occur at the nominal working pressure p_n of the system where a considered element is applied. Consequently, knowing the coefficients k_i of particular losses one is able to determine losses and power efficiency (total, volumetric, pressure and mechanical one) of elements operating in a driving system as well as total efficiency of a system with a given motor speed control structure in function of the velocity coefficient $\overline{\omega}_M$ and the hydraulic motor loading coefficient $\overline{M}_M$ as well as the hydraulic oil viscosity ν [9].

The library of the coefficients ki makes it possible , by using a numerical method, to assess power efficiency of a hydrostatic drive of a given motor speed control structure, in every point of the hydrostatic drive working field determined by motor shaft speed and load coefficents.

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CONTACT WITH THE AUTHOR

Agnieszka Maczyszyn
Faculty of Ocean Engineering and Shipbuilding
Gdańsk University of Technology
11/12 Narutowicz St.
80 – 233 Gdańsk
POLAND

Phone: +48-58-347-21-32
e-mail: agnieszka.maczyszyn@pg.gda.pl