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Parameter study on the influence of a radial groove design on the drag torque of wet clutch discs in comparison with analytical models

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Abstract: A considerable part of the power loss in disengaged wet clutches is caused by viscous shearing of the cooling oil between the clutch discs. Reducing this drag loss as far as possible is the objective of current research. This contribution deals with the measurement and analytical computation of the drag torque of a clutch disc with radial grooving. Operating parameters and diverse geometrical parameters such as groove width, depth, angle, or number are varied. A newly developed single-disc test rig by which the dependencies of the drag torque are able to be examined is used for measuring. Conclusions to the cause of the fluid flow behaviour are drawn and the results are compared to analytical calculation models.

Keywords: Clutch disc, Friction measurement, Fluid mechanics, Analytical model

Nomenclature

a	[Pas]	coefficient of the vogel equation	r^*	[m]	critical radius
$a_{\beta 1}$	[s]	coefficient of correction factor β_1	T	[Nm]	drag torque
A	[m^2]	area	T_{ir}	[Nm]	drag torque of inner flow region
A_g	[m^2]	grooved area of the disc	T_{cl}	[Nm]	drag torque of the clearance
A_{disc}	[m^2]	total area of the disc	T_{dg}	[Nm]	drag torque of disc gearing
b	[°C]	coefficient of the vogel equation	T_{fa}	[Nm]	drag torque due to oil flow in full filled section
$b_{\beta 1}$	[s^{-1}]	coefficient of correction factor β_1	T_{ra}	[Nm]	drag torque due to oil flow in ruptured section
c	[°C]	coefficient of the vogel equation	T_{rm}	[Nm]	drag torque due to mist flow in ruptured section
$c_{\beta 1}$	[-]	coefficient of correction factor β_1	v	[m/s]	velocity
$c_{p,oil}$	[J/(kg·K)]	specific heat capacity of the oil	$v_{\theta 1}$	[m/s]	circumferential velocity friction disc
d_{disc}	[m]	disc diameter	$v_{\theta 2}$	[m/s]	circumferential velocity separator disc
d_g	[m]	groove depth	w_g	[m]	groove width
$h_{br,eff}$	[m]	effective clearance of disc bracket	β_1	[-]	correction factor flow rate
h_{cl}	[m]	clearance	β_2	[-]	correction factor clearance
$h_{g,eff}$	[m]	effective clearance for grooved disc	$\dot{\gamma}$	[s^{-1}]	shear rate
h_p	[m]	pad height	γ	[-]	area ratio