DETERMINATION ANALYSIS OF TEMPERATURE REGIMES, FUNCTIONAL CHARACTERISTICS AND SLIDING CURVES OF A HYDRODYNAMIC CLUTCH

by

Božidar V. KRSTIĆ[a*], Milun J. BABIĆ[a], Vukić N. LAZIĆ[a], Vladimir N. RAIČEVIĆ[b], Milan Z. DESPOTOVIĆ[a], Dragan I. MILOSAVLJEVIĆ[a], and Vojislav B. KRSTIĆ[c]

[a] Faculty of Mechanical Engineering, University of Kragujevac, Kragujevac, Serbia
[b] Faculty of Technical Science, University of Kosovska Mitrovica, Kosovska Mitrovica, Serbia
[c] Faculty of Transport and Traffic Engineering, University of Belgrade, Belgrad, Serbia

Original scientific paper
UDC: 62.578:621.838.4
DOI: 10.2298/TSCI100412019K

Analysis of output quality of power transmitters is possible in position when characteristics are determined earlier. This is the reason why we focused on determination of these characteristics for a concrete power hydro-transmitter. This means that the investigation task primarily consisted of determination of functional characteristics, defining of the sliding curves and temperature regimes of a concrete hydrodynamic clutch. Results of velocity and pressure field investigations in the working space of this clutch, obtained by use of the same test setup, are the basis for determination and analysis of the functional characteristics, sliding curves and temperature regimes. In this work we also analyzed function of the hydrodynamic transmitter in assembly with an internal combustion engine, as well as a process of acceleration and deceleration of a vehicle with this assembly in it.

Key words: *hydrodynamic clutch, temperature regimes, sliding curves, operating characteristics of hydrodynamic clutch*

Introduction

Non regulate hydrodynamic clutch with the radial blades D370, produced by "14. October" from Kruševac (Serbia), for motor vehicle MTZ 100, is used as the object of research. From that purpose, original experimental equipment was developed. Task of the research: control of functional characteristics of hydrodynamic clutch D370 which is connected with diesel motor D-240T (Russian production) and establishing of sweep slide and temperature regimes. Before process of research operating characteristics hydrodynamic clutch D370 there is workspace in all regimes, first rather fortifying quality of closing,

* Corresponding author; e-mail: bkrstic@kg.ac.rs

phenomenon vibrations and fortifying degree work's calm [1-8]. Total capacity (100%) of hydrodynamic clutch D370 is 6,98l. During the research, temperature of oil was les then 100 ^{o}C.

Experimental researches the influence of individual factors on the characteristics of a hydrodynamic clutch motor vehicles

On the base of the acquired experimental data a conclusion can be drawn about shape and geometric measures of the hydrodynamic clutch driving cycles and at which working regimes they give the most favorable results. For conducting experimental researches, indirect measuring method is used, based on the definition of the pressure distributed on its walls. Non-regulate hydrodynamic clutch with the radial blades D370, produced by "14.October" from Kruševac – Serbia (figure 1), is used as the object of research.

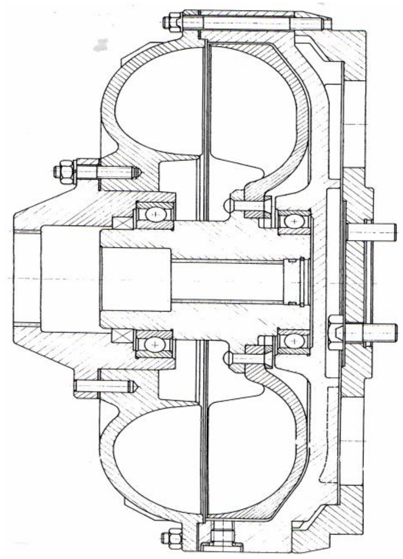

Figure 1. Object of research: Non-regulate hydrodynamic clutch with the radial blades D370

From that purpose original experimental equipment was developed (figure 3). Original testing plant has been used and the review of the same is shown in the figure 2, it consists of electric motor (A), reducer (B), accepted device (C), figured dimension device (D) and measuring shafts (E). Object of the research (hydrodynamic clutch) is placed in the accepted device (C), which presents original solution [1] and enables the exchange of the size of the clearance between moving blades of the hydrodynamic clutch.

Figure 2. Schematically review of the used testing plant used

Number of the pump circuit blades is 45 and of the turbine is 43 (figure 1). Brake (D) is of the hydraulic type UT30, produced by Schenk (figure 4). Reducer (B) increases the possibility for the utilization the plant. Following measuring equipment, produced by company HBM, has been used measuring shafts, type T30FN3/5, with a pressure of P4AK, universal measuring device for electrical sizes and amplifier.

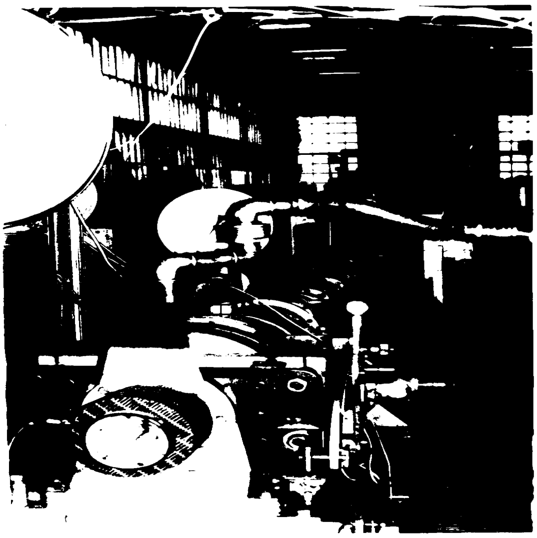

Figure 3. Experimental equipment

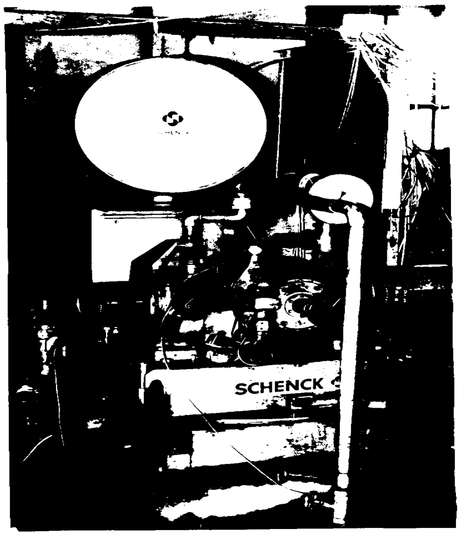

Figure 4. Brake device UT30 Schenk

Researchers are conducted at the three different values. First the angle turning speed of the pump cycle, second values for clearance between the paddle cycles, and third values for the sliding coefficient at the hydrodynamic clutch charging of 80%. Also, mineral oil with viscosity of 21 mm^2/s, at 323 K, is used.

Research results

Research results are presented in table 1 and then there are designed: diagrams 7 for different values of degrees charging (figures 5, 6 and 7); diagrams $M = M(n_1,V)$ for different values of skidding coefficient (figures 8, 9 and 10); diagrams $M = M (s, n_1)$ by charging of 85% and oil temperature 80 ^oC (figure 11); diagrams $M = M (s, T)$ by charging of 85% and number of revolution of output shaft 1500 rpm (figure 12); diagrams $t_u = t_u (s, T)$ by charging of 85%, number of revolution of output shaft 1500 rpm and temperature of surroundings 19 ^oC (figure 13). In figure 14 is presented influence of sudden break output shaft on hydrodynamic clutch D370 transitive processes. The influence of acceleration of output shaft (after sudden disembarrassment) on hydrodynamic clutch D370 transitive processes is presented in figure 15. In figure 16 are presented characteristics of common work hydrodynamic clutch D370 a diesel motor. Their work is stable in all working regimes.

Table 1. Research results

V [%]	80	80	80	70	70	70	60	60
n_1 [rpm]	1517	1022	765	1517	1022	765	1517	1022
s = 2 [%]								
n_2 [rpm]	1484	1002	750	1485	1002		1483	
M [Nm]	68	20.5	8.2	47.1	14.7		28.1	
P [kW]	10.56	2.15	0.64	7.32	1.54		4.36	
t [ºC]	29	21	27	42	33		27.2	
s = 3 [%]								
n_2 [rpm]	1468	991	742	1467	991	741	1468	993
M [Nm]	124	34.6	15.6	90.2	27.8	12.7	43.9	13.9
P [kW]	19.05	3.59	1.21	13.85	288	0.89	6.75	1.44
t [ºC]	34	23	27	48	33.5	27	28	27
s = 4 [%]								
n_2 [rpm]	1453	981	734	1455	981	735	1452	981
M [Nm]	184	52.2	23.2	127	40	17.6	67.2	21.7
P [kW]	27.98	5.36	1.78	19.34	4.11	1.35	10.22	2.23
t [ºC]	42	25	28	53	33.5	27.5	30	27
s = 6 [%]								
n_2 [rpm]	1422	960	721	1422	962	718	1422	959
M [Nm]	279	101	41.5	219.2	66.8	30	114.3	37.2
P [kW]	41.54	10.15	3.14	32.64	6.37	2.25	18.16	3.74
t [ºC]	58.5	37.5	32	58	39	33	42	31
s = 10 [%]								
n_2 [rpm]	1352	914	690	1365	922	690	1360	920
M [Nm]	470	139	69.2	320	114	53.3	184	65
P [kW]	66.5	13.3	5	45.73	11	3.85	26.2	6.26
t [ºC]	120	52	43	100	47	36	78	36.5
s=100 [%]								
n_2 [rpm]	0	0	0	0	0	0	0	0
M [Nm]	627	226	117	375	159	53	229	97.9
P [kW]	0	0	0	0	0	0	0	0
t [ºC]	85	75	73.5	95	75	90	85	80

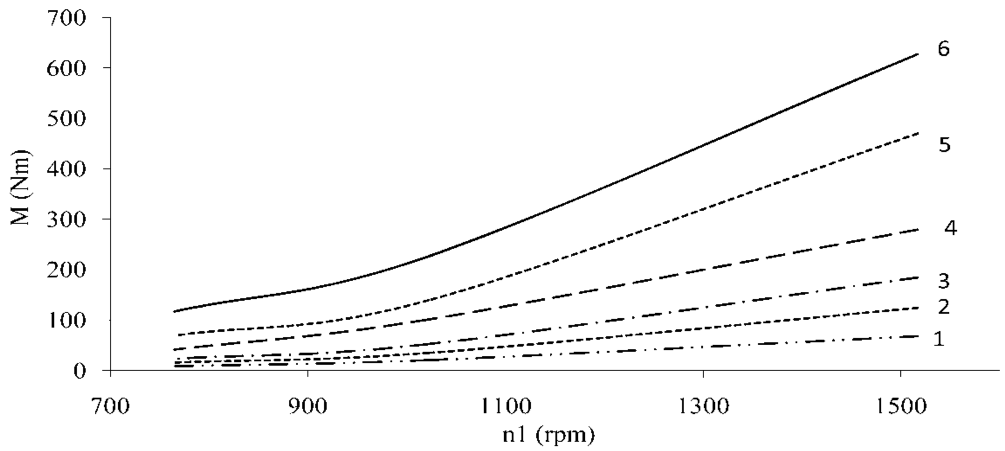

Figure 5. Influence of revolution input shaft t hydrodynamic clutch D370 by *V* = 80% for different values of sliding (1 – *s* = 2%, 2 – *s* = 3%, 3 – *s* = 4%, 4 – *s* = 6%, 5 – *s* = 10%, 6 – *s* = 100%)

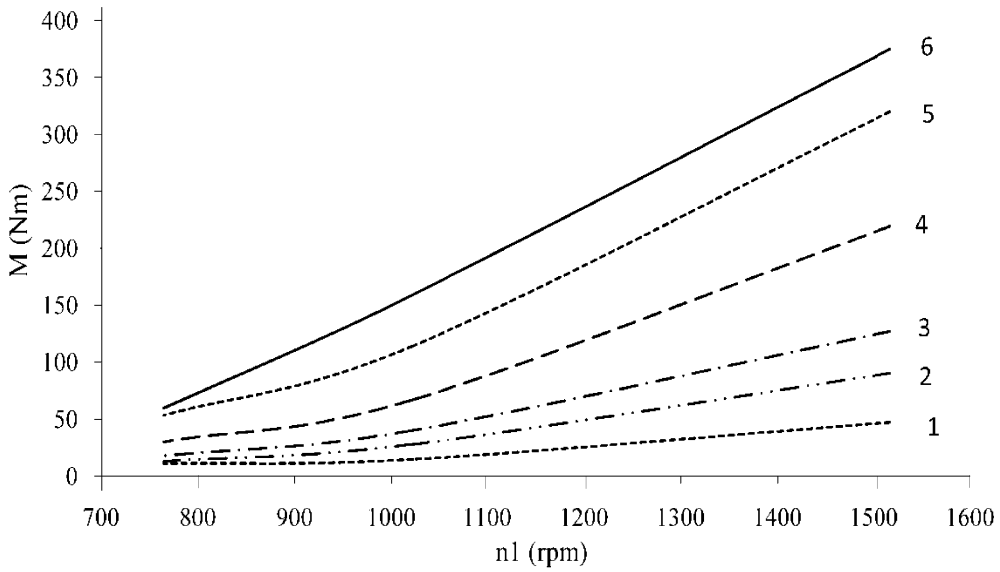

Figure 6. Influence of revolution input shaft hydrodynamic clutch D370 by V = 70% for different values of sliding (1 – *s* = 2%, 2 – *s* = 3%, 3 – *s* = 4%, 4 – *s* = 6%, 5 – *s* = 10%, 6 – *s* = 100%)

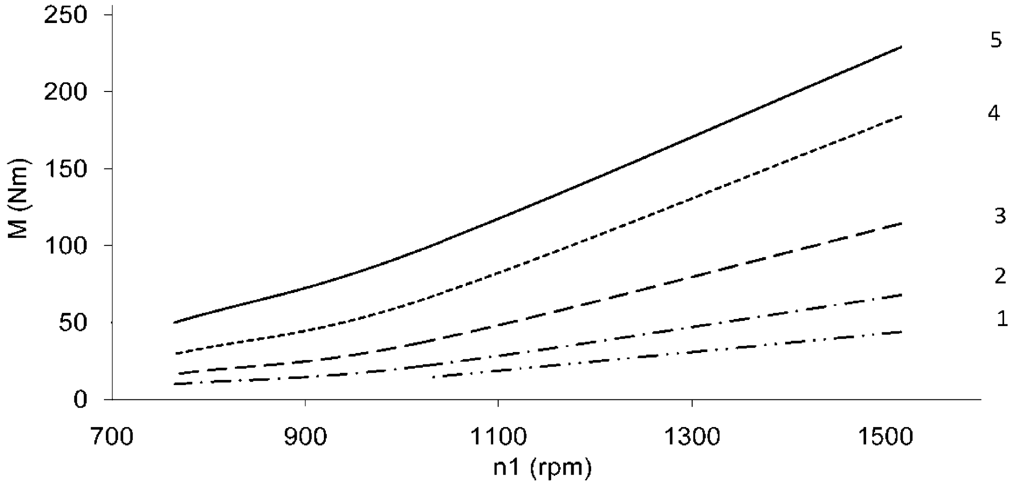

Figure 7. Influence of revolution input shaft hydrodynamic clutch D370 by V=60% for different values of sliding (1 – *s* = 3%, 2 – *s* = 4%, 3 – *s* = 6%, 4 – *s* = 10%, 5 – *s* = 100%)

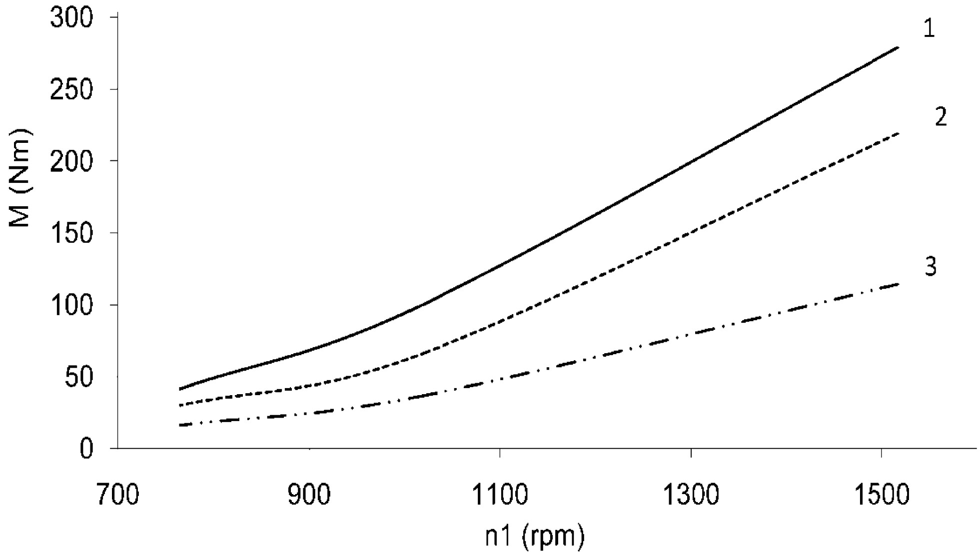

Figure 8. Influence of revolution input shaft hydrodynamic clutch D370 by s = 3% for different values of charge (1 – *V* = 80%, 2 – *V* = 70%, 3 – *V* = 60%)

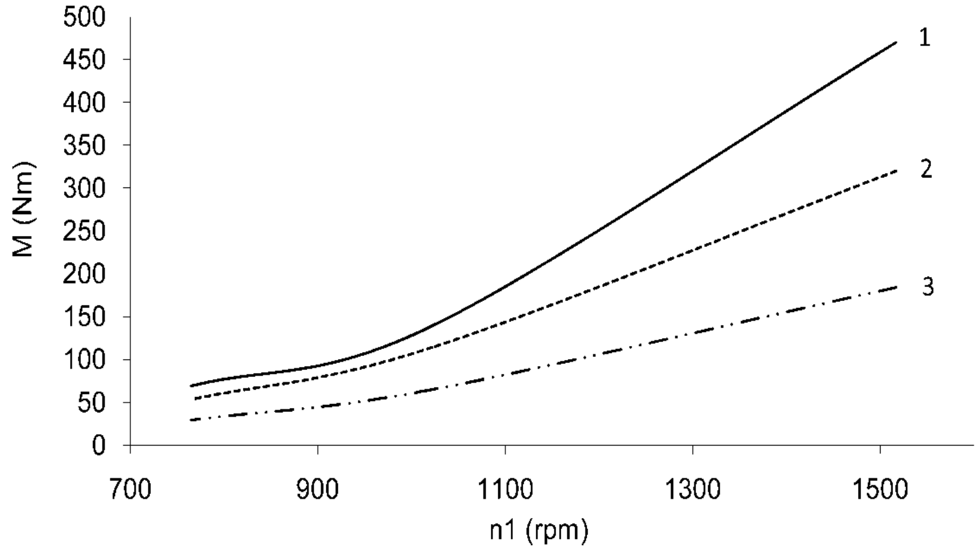

Figure 9. Influence torque hydrodynamic clutch D370 of revolution input shaft by s=10% for different values of change (1 – *V* = 80%, 2 – *V* = 70%, 3 – *V* = 60%)

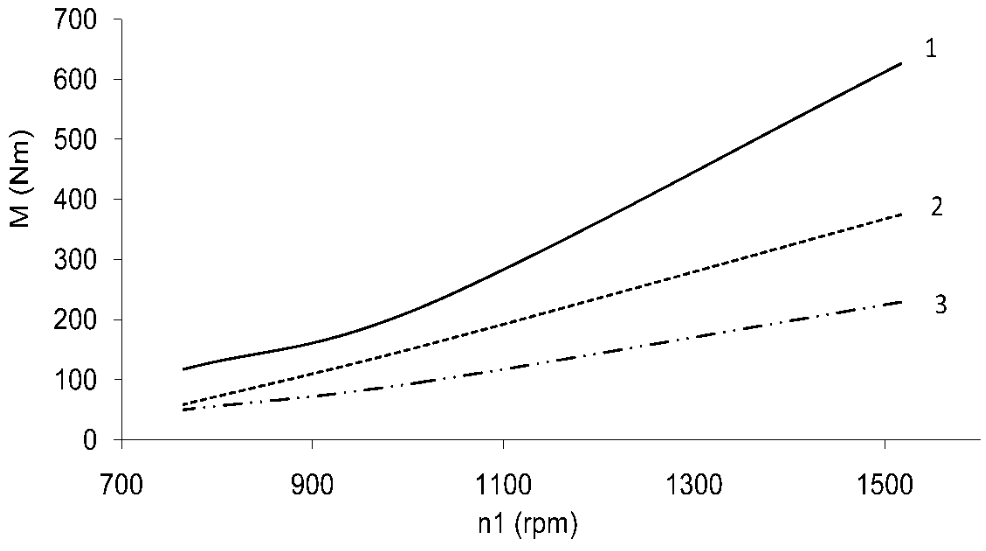

Figure.10. Influence of revolution input shaft hydrodynamic clutch D370 by s=100% for different values of charging(1 – *V* = 80%, 2 – *V* = 70%, 3 – *V* = 60%)

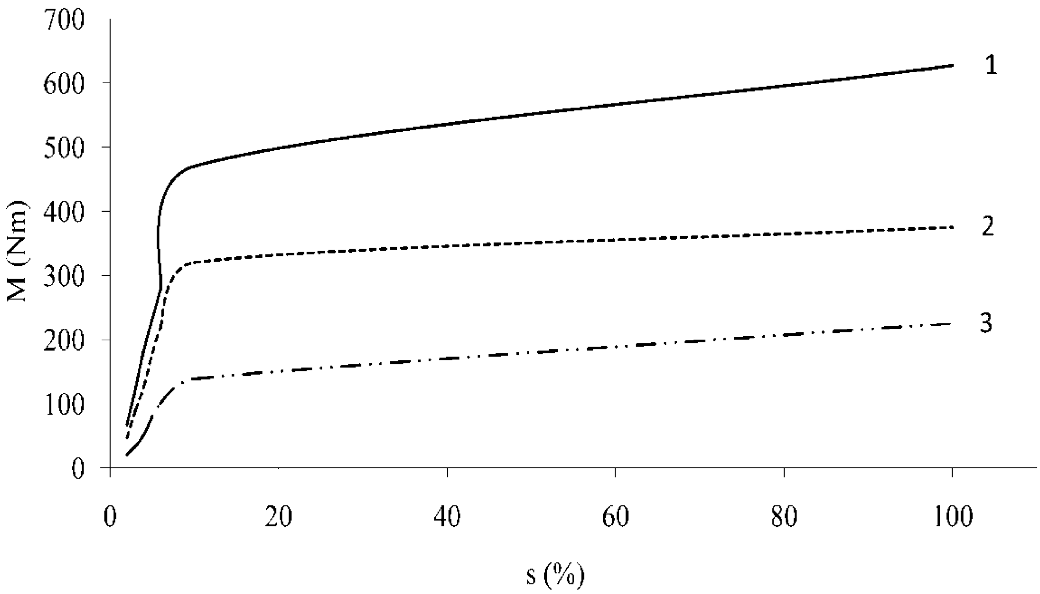

Figure 11. Influence revolution of input shaft hydrodynamic clutch (1–n_1=1000 rpm, 2 – n_1=750 rpm, 3–n_1= 500 rpm) on dependence $M = M$(s), by charging V=85% and temperature of work fluid t_u = 80 °C

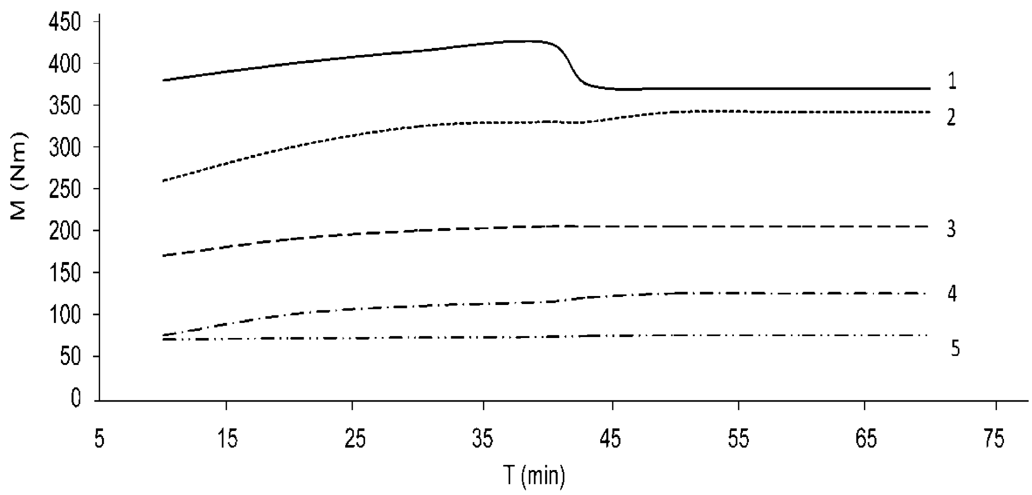

Figure 12. Influence of work regime hydrodynamic clutch D370, in function of sliding (1 – s=8%, 2 – s=6%, 3 – s=4%, 4 – s=3%, 5 – s=2%), on M=M(T), by fullness V=85% and n_1 =1500 rpm end temperature t_o=19 °C

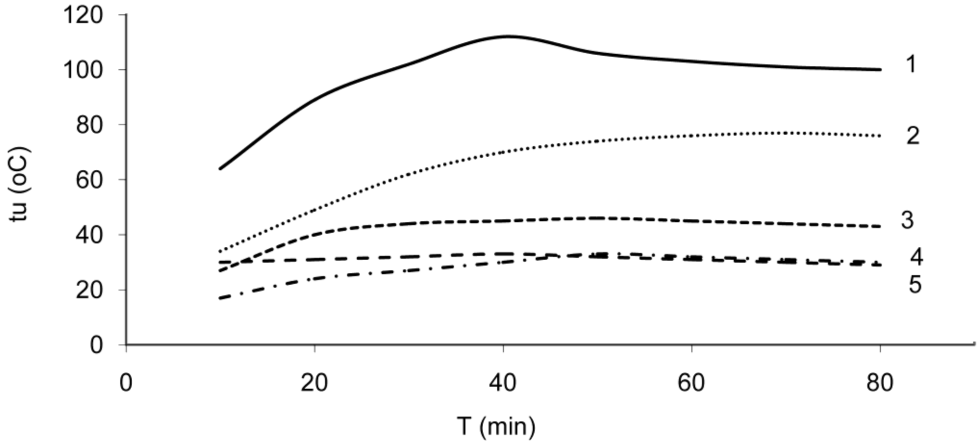

Figure 13. Influence of work regime of hydrodynamic clutch D370, in function of sliding (1 – *s*=8%, 2 – *s*=6%, 3 – *s*=4%, 4 – *s*=3%, 5 – *s*=2%), on dependence $t_u = t_u (T)$, by charge *V*=85% i n_1=1500 rpm and external temperature t_o=19 °C

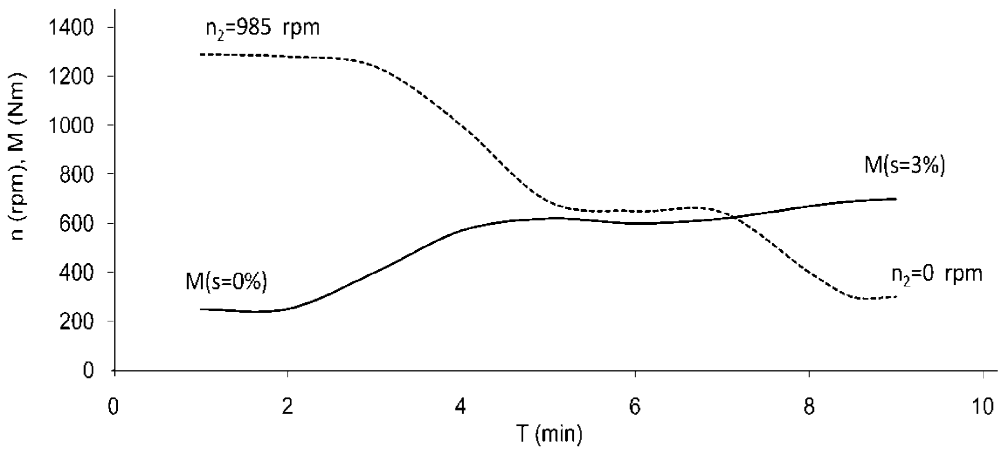

Figure 14. Influence of sudden braking output shaft after transient by hydrodynamic clutch D370 by sliding *s*=3%, by n_1=1015 o/min and t_u=38 °C

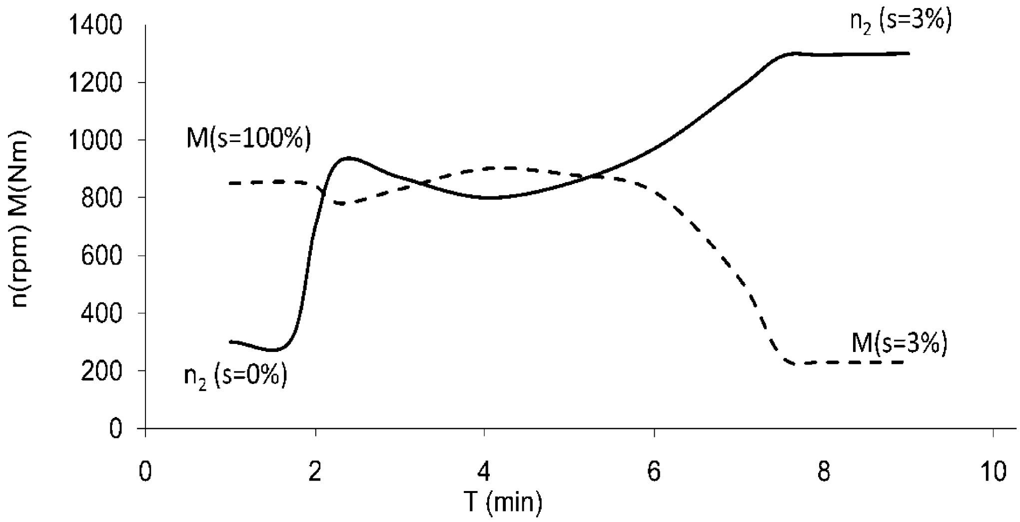

Figure 15. Influence of runway output shaft hydrodynamic clutch D370 (after a sudden discharge) on transient of hydrodynamic clutch by sliding s = 3%, by n_1 = 1015 rpm and t_u= 38 °C

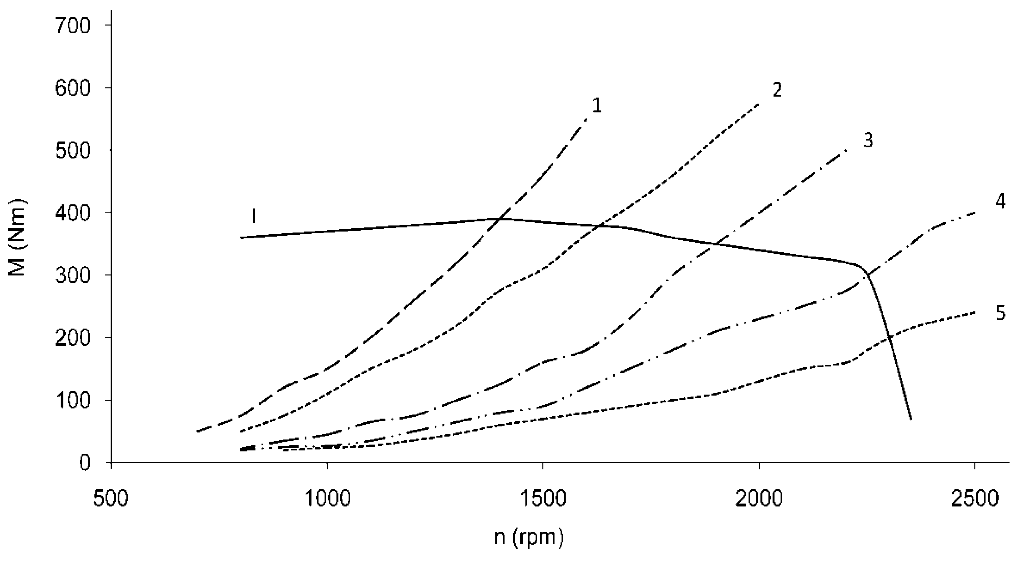

Figure 16. Characteristics communal work hydrodynamic clutch D370 and diesel motor D240T (I), by V = 85% for different values of sliding (1 – s = 100%, 2 – s = 10%, 3 – s = 6%, 4 – s = 4%, 5 – s = 3%)

Concluding remarks

Analysis of results this research and experiment by application of driving motor D240T, rather in tractor MTZ 100 (Russian production), leads to the following conclusion:

1. Research results of major number hydrodynamic clutch D370 are different each other. Reason for that, should be find primarily in research conditions (climatic, temperature of stationary oil, oil quantity, different in damages for friction in measuring equipment as consequence of different heated and measuring mistakes);
2. The best effects of power transfer (on sliding s = 2-4%) are obtained by charging degree of 80-85% (5,584÷5,933) dm^3. Also, curves s = const are obtained, which have same character than other which are obtained by theoretical way;
3. Stationary temperature of oil in hydrodynamic clutch depends upon work regime and climatic conditions. For work regimes s = 2-4% and surroundings temperature t = 15-20 ^oC, stationary temperature is between 31 and 46 ^oC. Increase or decrease of surroundings temperature influences increase or decrease worth this temperature. Obtained results of stationary oil temperature in hydrodynamic clutch, by continual work in function of slide, display that critical regimes keep informed by slide s = 7-8%, while by s = 7% and surroundings temperature t_o = 15 ^oC, oil temperature become stationary slightly below t_u = 100 ^oC.
4. During work of hydrodynamic clutch D370 with s = 8% there is stable increase of temperature, with, for approximately 60 min challenges melting of plug assurance and phenomenon dropping oil out it. One can expect, in real conditions of exploitation that extreme worth of oil temperature is t_u < 70 ^oC because temperature of regimes, by nominal values of slide (is s = 3%). By that, beside work regime, on temperature regime climatic and built surroundings have influence, too;
5. Torque curves $M = M(s)$ are shown tendency of increase. Torque until s = 50%, and then bland decrease of torque with other decrease slide, until work regime where s = 0%. Toward this characteristic there appreciate its elasticity, with define with relation of output torque, by s = 100% and s = 3%, and it is $K = M_2(s = 100\%)/M_2(s = 3\%)$ = 4-5. Experiences are display that the best results, in conditions of real exploitation hydrodynamic clutch, are of values of $K < 3$. Course of curve $M = M(s)$ displays on stiffness hydrodynamic clutch and it isn't corresponding to reference;
6. Analysis of diagram communal work of diesel motor D240T and hydrodynamic clutch D370 (figure 16), one can conclude that the best utilized motor power realizes in work regimes hydrodynamic clutch D370 s = 2-4%, while motor work by close to s = 100% performance near extreme torque and by number of n = 1270 rpm revolution. Continual work regime of hydrodynamic clutch D370 unfolds by normal motor torque, by slide s = 2.8-2.9%. Common work hydrodynamic clutch D370 and motor D240T will be stable, reliable and without phenomenon of motor quenching with regard to work of motor with number revolution than the least stable, on start regime hydrodynamic clutch (s = 100%). Is case of complete stopping of output shaft hydrodynamic clutch (i = 0, s = 100%), it's necessary that operating motor has stable work without quenching, and
7. By motor work on dead time (n = 600-700 rpm) on nominal work regime hydrodynamic clutch D370 the worth of torque is M = 15-20 Nm, while on same work regime of motor start torque, this clutch is $M(s=100\%)<150$ Nm. Rather decrease of worth output torque

by hydrodynamic clutch work on regime *s* = 100% and motor by the least number revolution (*n* = 600-700 rpm), it's workspace to do optimization of work area hydrodynamic clutch D370, firstly because results the research of pressure and speed fields in it's work area which are given in the work [1].

Nomenclature

V	– charging degree [%]	*T*	– time [s]
n	– number revolution [rpm]	*M*	– torque [Nm]
s	– sliding [%]	*M* =*M*(*s*)	– torque curves
t	– temperature [^{o}C]	D240T	– diesel motor
t_o	– surroundings temperature [^{o}C]	D370	– hydrodynamic clutch
t_u	– oil temperature [^{o} C]	MTZ100	– tractor

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Paper submitted: April 12, 2010
Paper revised: May 14, 2010
Paper accepted: July 05, 2010