THE ANNALS OF “DUNAREA DE JOS” UNIVERSITY OF GALATI
FASCICLE XIV MECHANICAL ENGINEERING, ISSN 1224 – 5615
2003

FRICTION COUPLING AND SPECIFIC PHENOMENA

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ABSTRACT

The present work object is to make the transitory conditions evolution evident,in coupling, by considering the friction moment which depends on angular speed. The friction moment is considered to be dependent on the relative sliding between the two coupling parts.

1.General presentation.

The friction couplings realise the load coupling of a machine part that has to receive the rotation motion from a generating source.

During the time when the guided coupling part reaches the leading coupling part revolution, the friction moment, acts as a driving moment for the guided parts and as a load moment for the leading part and the generating source.

The friction moment is considered to be dependent on the relative sliding between the two coupling parts.

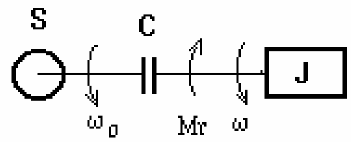

Diagram 1. Transmision with one coupling

The pressing force of both coupling parts is considered to be constant during the time.

In same circumstances (i.e.: the electromagnetic couplings) the pressing force presents an instability, as a result of the electric transitory conditions but this instability covers a very short period of time;that phenomenon is treated in a broad sense in work [1]

The present work object is to make the transitory conditions evolution evident,in coupling, by considering the friction moment which depends on angular speed. Therefore the load moment will be considered to be free of revolution.

2.Working equations of the coupling

The coupling C from diagram 1 realises the junction between the inertia mass, J, with its own resistant moment, Mr, and the motion source,S.

The guided part revolution,ω, increases from zero to ωo.

As the guided part starts among the coupling parts, a relative movement rises is represented by the value ω_r.

$$\omega r = \omega o - \omega \qquad (1)$$

The friction moment between the coupling parts, M_{fr}, is considered to be dependent on ω_r, as:

$$Mfr = Mfr(\omega r) \qquad (2)$$

The guided part movement, during the transitory conditions, is described by the equation:

$$Mfr(\omega r) - Mr = J\frac{d\omega}{dt} \qquad (3)$$

In expression (3), both ω_r and ω, depend on the time.

From expression (1) it may be obberved that dω = $-d\omega_r$, so that expression (3) becomes:

$$Mfr(\omega r) - Mr = -J\frac{d\omega r}{dt} \qquad (4)$$

The differential equation (4) having separable variables, is easy to resolve:

$$-J\int_{\omega o}^{\omega r}\frac{d\omega r}{Mfr(\omega r)-Mr} = \int_{o}^{t} dt \qquad (5)$$

Research on Romanian electromagnetic coupling (e.g. 8211314C1 and 8401911C1, respective 100 N.m and 50 N m) [1].[2] makes it evident that the friction moment is signifiant depending on relative angular speed, such as:

$$Mfr(\omega r) = k \cdot (1 + e^{a \cdot \omega r}) \qquad (6)$$

Expression (6) is available after electric transitory conditions, more exact, after same parts of seconds. During this time, the guided part realises just a few complete rotations.

Taking notice of expression (6), expression (5) becomes (7) :

$$J \int_{\omega r}^{\omega 0} \frac{d\omega r}{k \cdot (1 + e^{a \cdot \omega r}) - Mr} = t \qquad (7)$$

From expression (7), it is possible to obtain:

$$t = \frac{J}{a \cdot (k-Mr)} [a \cdot (\omega o - \omega r) + \ln \frac{ke^{a\omega r} + k - Mr}{ke^{a\omega o} + k - Mr}] \qquad (8)$$

sliding among the coupling parts acquires the value ω_r. At the start of the process end of the guided part, with the duration t_c, th Expression (8) shows that after a certain period of time (t) passes, the relative e sliding ω_r becomes zero.

Accordingly, the start time is:

$$tc = \frac{J}{a(k-Mr)} [a \cdot \omega o + \ln \frac{2k-Mr}{k \cdot e^{a\omega o} + k - Mr}] \qquad (9)$$

In analyzing expression (9), the start time is considered to be zero or it can be ignored if the moved mass has the inertia moment zero or as long as the resistant moment M_r is smaller than the friction moment M_{fr}

In the case that the friction moment expression doesn't satisfy (6), the above mentioned observation may be deduced from expression (5), too.

3. Power aspects about the friction couplings

It was shown that the coupling parts perform a relative movement, on which crossing there is the friction moment too. Therefore it appears a friction mechanical work with the momentary value, on modulus, is as follows:

$$dL = M_{fr}(\omega_r) \cdot \omega_r \cdot dt \qquad (10)$$

Replacing the dt value from expression (4) into expression (10) will provide the following result:

$$L = J \int_{o}^{\omega o} \frac{Mfr(\omega r)}{Mfr(\omega r) - Mr} \omega r \, d\omega r \qquad (11)$$

In the case that the start of the guided port takes place without resistant moment, Mr, it must be underlined that the mechanical work is :

$$L = J \frac{\omega o^2}{2} \qquad (12)$$

If the guided part doesn't contain inertia mass J=0, the friction mechanical work is zero, regardless of the resistant movement value, Mr, as long as the following expression exists $Mr < M_{fr}(\omega_r)$

In the case the guided part has its inertia mass,J<>0 and resistant moment, Mr from the expression (11) it may be deduce that the friction energy grows in the same time while the rezistant moment gets closer in value with the friction moment.

The movement source of the coupling, generates during the start off a mechanical work, L_s, described by the following expression:

$$dLs = Mfr \cdot \omega o \cdot dt \qquad (13)$$

Replacing dt from expression (4) in expression (13) it is obtained (14)

$$Ls = J\omega_o \int_{o}^{\omega_o} \frac{M_{fr}(\omega_r)}{M_{fr}(\omega_r) - M_r} d\omega_r \qquad (14)$$

In the case that the resistant moment Mr is missing, the Ls expression is:

$$Ls = J \cdot \omega o^2 \qquad (15)$$

In the expression (15) it may be seen that the L_s is twice that the energy transfered the guided part.

In the situation in which J, the movement source of the leading part has to assure also the neccessary energy to transfer into the friction energy.

4. Conclusions

In most cases, the friction couplings are designed to transfer a certain moment. In the working time, the transitory conditions and the wear are very hard influenced by the inertia masses.

As the elements regarding the coupling working are missing, it is better in these situations to be indicated by the producer one proper element, such as the friction energy value which is carry on untill the working out time.

References

[1] **Gheorghe Oproescu**:(1993) "*Procese de cuplare la cuplaje ectromagnetice*". Buletinul primului colocviu national tehnic interdisciplinar, Braila, pg. 13-17.

[2] **Gheorghe Oproescu**:(1994) "*Modelarea regimului tranzitoriu in cuplajele electromagnetice*". Buletinul Conferintei Nationale de Dinamica Masinilor, Brasov 1994, pg. 115-119.