VÝVOJ ZAŘÍZENÍ PRO ZKOUŠKY SOUČÁSTÍ POHONŮ A JEHO POUŽITÍ PRO ZJIŠŤOVÁNÍ SPOLEHLIVOSTI, PRACOVNÍCH A TEPELNÝCH PARAMETRŮ

DEVELOPMENT OF EQUIPMENT FOR TESTING OF DRIVE PARTS AND ITS MONITORING APPLICATION OF WORK, HEAT AND RELIABILITY PARAMETERS

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Abstrakt

Příspěvek popisuje vývoj zkušebního zařízení a zkušebních metod pro testy průmyslových kotoučových brzd. Brzdný moment, úhlová rychlost, tepelné a silové poměry ovlivňují spolehlivost a životnost brzd. Brzdy jsou zkoušeny simulovaným zatížením při různých pracovních podmínkách během střednědobých a dlouhodobých zkoušek. Pracovní parametry jsou prověřovány při provozu brzdy s opakovanými provozními cykly. Tyto cykly jsou složeny z rozběhu, stanovené doby běhu, doběhu a prodlevy v klidu před rozběhem následujícího cyklu. Měřenými parametry jsou teplota brzdy, silové poměry v brzdě, brzdný moment a úhlová rychlost. Řízení zkoušky, ovládání pracovních cyklů a sběr měřených dat zajišťuje osobní počítač, vybavený měřicí kartou a programem vytvořeným ve vývojovém prostředí LabVIEW.

Klíčová slova: Průmyslová kotoučová brzda, Životnost brzdy, Teplota brzdy, Brzdný moment.

Abstract

This paper describes the development of testing equipment and testing methods for tests of industrial disk brakes. The brake torque, angular velocity and thermal and tension conditions affect reliability and service life of brakes. The brakes are tested by simulating at different operating conditions by medium-term and long-term tests. Working conditions are probed during brake operation with repeated process cycles. These cycles are arranged of run-up, specified running, braked run-out and stationary delay before next run-up. Measured parameters are temperature of brake, tension conditions, brake torque and angular velocity. Testing process, running cycle control and saving measured data provides a personal computer which includes measuring card and programme designed in LabVIEW developing system.

Key words: Industrial disk brake, Service life of brake, Temperature of brake, Brake torque.

INTRODUCTION

Industrial brakes are used in machine drives, where they serve as a safety device. Their purpose is to secure device stopping time after motor turn-off and to secure device fixing after device stop. Stopping time is given by secure requirement.

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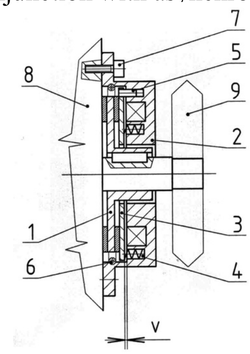
These brakes should be use for devices with high inertia moment, high revolution and long stopping time without using brakes. Run-out controlled by brake must be gradual with aspect for possibility of device damage by beats. An example of industrial disk brake is shown in Fig. 1. This brake is used in conjunction with asynchronous motor.



1 – Brake disc
2 – Magnet body
3 – Armature plate
4 – Helical spring
5 – Locating pin of armature plate
6 - Ring – limiter of armature plate travel
7 – Brake fixing screw
8 – Motor body
9 – Ventilator fan
V – Armature clearance

Fig.1

High inertia moment and high accumulated energy cause of release big amount of heat in full brake application and brake is strongly heated-up. Therefore heat conditions in running markedly affect brake dependability and life-time. Temperature of brakes in running can't exceed maximum permissible value which in first depends on thermal endurance of brake control mechanism. Thermal conditions are probed during brake operation with repeated process cycles. These cycles are arranged of run-up, specified running, braked run-out and stationary delay before next run-up. Measured parameter is temperature of brake in one or more places. Theirs placements depend on designated location of critical places which are the most endangered by brake overheat. In some places is difficult to secure measure of heat. Therefore is necessary to describe heat field in brake mechanism and temperature dependence in various places in order to be possible to specify temperature in other brake mechanism area. Temperature specification is made by measuring in easy accessible places.

The goal of heat conditions measurements in brake running is to designate basic heat parameter of brake. It means amount of temperature rise after one brake application in dependence on amount of brake inertia moment load and time behaviour of next cooling. Amount of temperature rise is given by thermal variation of elected measuring place at start and end of brake running-out. Initial temperature corresponds with steady condition where thermal variations are low and theirs changes are proceeding slowly. Temperature after full brake application is given by maximum value after brake stop. After brake stop follow lag for single brake parts temperature equalization and cooling to steady condition which makes possible next brake operation cycle. During this lag is measured temperature fall behaviour in elected point. Brake cooling speed depends on immediate brake temperature measurement and decline from maximum speed after brake stop to minimum when single brake parts temperature are equalized and are like ambient temperature. An course of brake cooling graph is shown in Fig.2. In the graph an effect of cooling mode can be observed. After device stop can the motor run-up again and a ventilator fan intensive cools the brake or the motor is at standstill and brake cooling is slow.

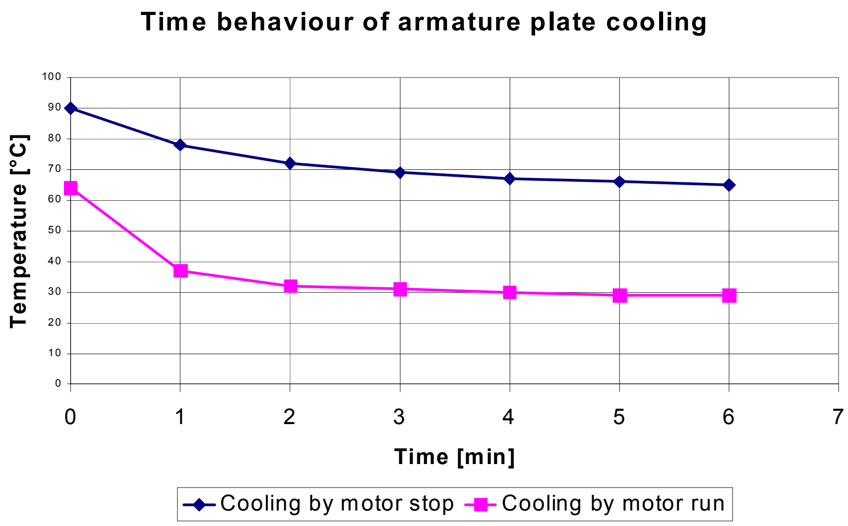


Fig.2

Main purpose of temperature parameter values investigation is acquisition of data for medium-term testing mode chooses for determination of permissible operating brake mode. This permissible mode is determined by possible amount of repeatable full brake applications during time unit. In this time brake can't be overheated over permissible value and/or damaged.

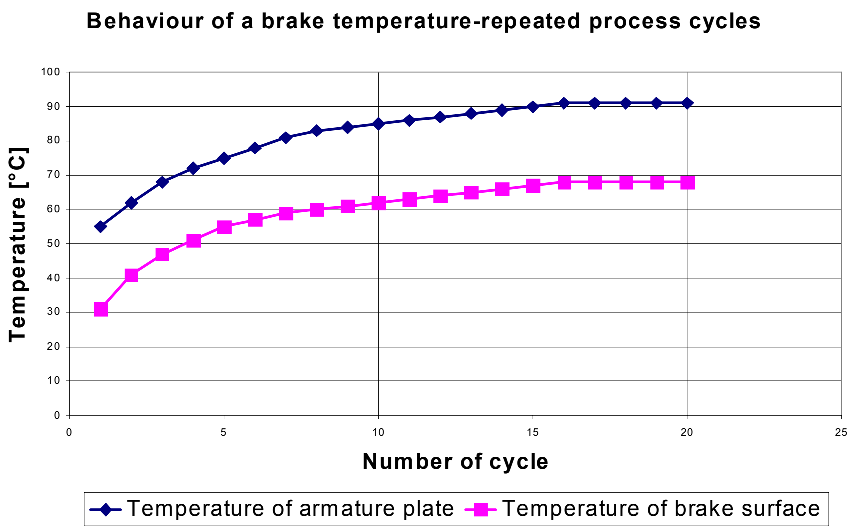


Fig. 3

On base of verified medium-term testing mode is possible to carry out long-term testing which verify brake dependability and life-time in continuous working. Brake is being loaded by repeated operating cycles during these testing. These operating cycles follows successively. Every working cycle is arranged of run-up to specified revolutions, specified constant speed running, run-out where motional energy is exploited in brake and stationary delay. During testing is being watched temperature in elected measure places or possibly thermal field in mechanism of brake. Brake temperature can't exceed permissible value. In right selection of operating cycle parameter is being maximal reached temperature ´s value in single cooling cycles after initial fast growing make stable. Size of this stable value depends on amount of brake loading and process cycles parameters. Right operating cycle selection parameter must secure sufficient cooling after every brake stop. An course of a brake temperature rise during repeated process cycles is shown in Fig.3. At start of a brake operation the temperature increases quick and gradually stabilizes on stationary temperature. The graph shows a course of temperature in various places and its difference. Next determined work parameters are static and dynamic brake moment, size of beam disk and brake shoe and its change during brake activity. Static brake moment is being determined as an amount of brake load moment in standstill in moment of brake slip. Dynamic brake moment is being measured during brake run-out. Purposeful brake gap is being measured in standstill and its size has an effect for dependability and functionality of brake. Testing process, running cycle control and saving measured data provides a personal computer which includes measuring card and programme designed in LabVIEW developing system. Brake is loaded by circular weight unit. Additional brake loading is possible to imitate by control motor run-out. Motor controlled by electric converter is decreasing revolution smoothly using specified function in parallel with brake function. Design of a brake testing equipment is shown in Fig.4. The brake is placed on a swing arm. A brake force sensing take an indicator attached on the brake.

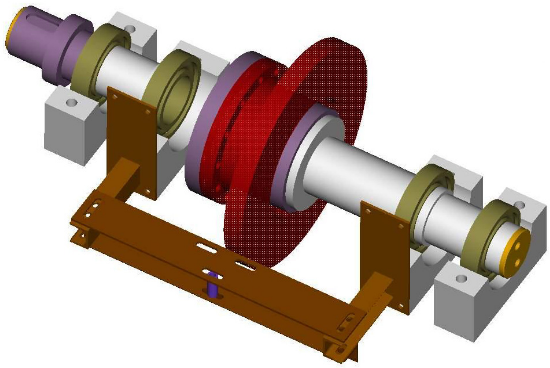


Fig. 4

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