Further, converter set MODULEX contains microprocessor-controlled regulator EMADYN, including software providing all necessary functions of the drive. A part of the regulator function may also be a possible control of primary high-voltage switches of supply transformers of individual drives, if they are equipped with closing, trip and under-voltage coil (high-voltage switches themselves are not a part of the supply). Microprocessor-controlled regulator EMADYN is adapted for external communication with the superior control system by means of serial line RS485, protocol MODBUS. By the help of this communication, it is possible to control microprocessor regulator EMADYN from the superior control system of the hoist, or to read selected parameters for "statistics" of the hoist, or to read selected parameters for "statistics" of the winding process. Microprocessor-controlled regulator EMADYN is equipped with an internal block for "post-mort" function, providing cyclic sensing of set parameters for diagnostics (analysis) of faulty actions. Part of the supply of the microprocessor-controlled regulator EMADYN is also simulation program SIMPA, enabling full control of the regulator from PC. The control panel with controllers and indicating lamps for basic control of the drive is located on the front door of the converter and regulation set MODULEX. Apart from the anchorage reversal we can provide field reversal as well.

Other components of the individual drives – supply transformers for armature converters, direct current air inductors, direct current quick-break switches – are without cover (protection IP00) in internal design with natural air cooling. The supply transformers for converters of actuation are in a cover (protection IP23) in internal design with natural air cooling. Five-field HV distributor is included in the supply, 3rd field of which is fully equipped for connection of filtration-compensatory device. Filtration-compensatory device itself is not a part of the supply, but it can be included in a separate order. Superior control of the hoist, as well as control of hydraulic brake system, and of system of control of bearing lubrication, is carried out by a set of four microprocessor control systems (produce of Allen Bradley, alternatively Tecomat), which are interconnected one to another by a duplicate redundant net. It enables exchange and sharing of selected parameters for the individual control systems, and at the same time, it also assures a very high level of the safeguard system of the hoist. The control panel of the machinist is equipped with a digital depth gauge and speedometer, joystick control of brakes and drive and, in addition to other check-up and control elements, it has inbuilt two large-screen touch operated displays serving for visualization of operational and faulty conditions. The machinist console is located in a noise and heat insulated cabin with integrated air-conditioning system.

Electrical part of AC-drive hoists (up to 1500 kW)

The electrical part is compactly designed and located in solely two distributors. The +RM regulation of the drive contains a four-quadrant frequency converter with a recuperation unit and integrated network filter, communication module of the redundant network ControlNet, as well as disconnecting and safety elements, control panel for visualization of operational reports, separatory transformer for auxiliary power supplies, UPS unit for back-up power-supply of the electronic circuits, as well as supplies of auxiliary voltages for the control automatons.

The distributor +RA for control and safeguard contains a PLC for hoist and drive control, PLC for control of the electro-hydraulic braking system, PLC for safeguard and visualization, communication modules of the redundant network ControlNet, modules of the distributed system inputs-outputs, input-output relay, safety circuit of the hoist and WD safekeeping units of the control systems.

Ergonomic control panel with a visualization touch screen, signaling and monitoring components, joystick controllers, and other equipment are all placed in a sound-proof insulated cabin to ensure comfort of the operating staff. The cabin is equipped by two lockable entry doors that are abundantly glazed in (total of 5 double glazed windows) and the front part of the cabin is doubly bent for better view of the machinist.

The use of the redundant communication network increases operational safety, while decreasing the assembly and maintenance requirements. This type of hoists is usually controlled manually, but it is possible to adjust all the machines for fully automated operation.

Basic technical data on selected types of frictional hoists

Frictional hoists are mostly manufactured on the basis of concrete extraction parameters and other specific requirements of the client. Power parameters of different hoists therefore vary greatly, and the difference can be registered even in two hoists of the same type (e.g. 4K4016 hoist is manufactured in double-motor and single-motor version, 2K3212 is designed in various power options, etc.). Hoists with the largest diameter of the frictional disc include a single-rope 1K7000, 1K6000, and a double-rope 2K6008. The most common four-rope hoists are 4K4016 and 4K5016.

Regarding the above mentioned, it is not feasible to give detailed data to all hoists. Below mentioned table shows technical data of selected hoists in order to give an overview of production scope. The manufacturer is nevertheless able to produce a hoist of basically any power parameters or technical solution.

Hoist type	---	1K6008	2K6008	2K3212	4K4016	4K5016	4K5018	6K5022	8K5032
Maximum static overbalance	kN	120	235	95	270	350	380	450	575
Nominal speed (order-dependent)	m/s	16	16	12	16	20	20	18	16,5
Nominal frictional disc diameter	mm	6000	6000	3200	4000	5000	5000	5000	5000
Nominal frictional disc width	mm	800	800	1200	1600	1600	1800	2200	3200
Number of hoisting ropes	---	1	2	2	4	4	4	6	8
Maximum rope diameter	mm	67	60	40	45	56	56	56	56
Number of hoisting motors	---	1	1	1	2	2	2	2	2
Nominal motor power	kW	3500	4400	1800	2 x 2400	2 x 4000	2 x 4400	2 x 5000	2 x 5500
Number of brake units	---	4 ÷ 24							
Working pressure of the braking apparatus	bar	145							

INCO engineering s.r.o.
Thámova 13
186 00 Praha 8
Czech Republic
sale@incoengineering.cz
www.incoengineering.cz

Frictional hoists

Frictional hoists

Frictional hoists are manufactured in a wide range of proportions and power. They are used for a single-action and double-action extraction from medium and higher depths. They find their use in mines as main double-action hoists, or as single-action skip automatons and, depending on the type of used transport containers; they are also excellent for the transport of people, material, inspection staff, etc. Their strength is the high payload availability (up to 60 tons) and lower procurement costs compared with the drum hoists of the same power. Another advantage is the high transport speed (up to 20 m/sec).

We manufacture single-rope to eight-rope frictional hoists with a nominal diameter from 3000 to 7000 mm. They are destined to be operated in the ground or tower-mounted machine halls, and all of them can be equipped to operate under the fully automated extraction mode.

The drive is designed as a single-motored or double-motored with installed power in a wide range from 250 kW to 11000 kW (2 x 5500 kW). With the exception of the lower power-levels, in which the drive is provided by an asynchronous motor with a gear-box, and the control is provided by a frequency converter, it altogether concerns drives with direct-current, slow-running motors, which are powered by a thyristor converter and digital regulator.

Mechanical part of frictional hoists includes:

- Single-rope to eight-rope frictional disc nominal diameter 3 – 7 m
- Main shaft located in the antifriction or sleeve bearings(customer-dependent)
- Gearbox – only with the AC drives (c. up to 1500 kW)
- Torque-flexible clutch VPS – only with AC drives
- Brake pedestals fitted with brake units
- Hydraulic distribution
- Electro-hydraulic system for lubrication and control of brake units
- Electro-hydraulic system for main bearings' lubrication
- Drives of the sensors
- Frames, covers, anchorages
- Air-conditioned machinist cabin for the control panel placement
- Equalizing device for working the frictional lining

Electrical part of the DC-drive frictional hoists includes:

- Slow-speed DC motor
- Distributor of high voltage +VN
- Converter transformer
- Excitation transformer
- High-speed switch and suppressor

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- Thyristor converter with a regulation and converter set
- +RM distributor of auxiliary drives
- +RA distributor for control and safeguard
- +RB2 distributor of the electrical part of the electro-hydraulic brake system
- Control panel of the machinist +RT with a digital depth-gauge, control and inspection elements and a central visualization system of operational and faulty conditions (in the air-conditioned cabin).

Electrical part of the AC-drive frictional hoists includes:

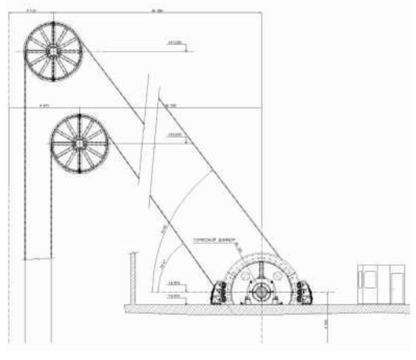
- AC motor of the drive (c. up to 1500 kW)
- Distributor for drive regulation with a four-quadrant frequency converter, recuperation unit, and network filter.
- +RA distributor for the control and safeguard containing a set of programmable automatons and other equipment
- Control panel of the machinist +RT with a digital depth-gauge, control and inspection elements and a central visualization system of operational and faulty conditions (in the air-conditioned cabin).

Mechanical part

All the manufactured frictional hoists exhibit a similar structural design of mechanical parts, and also principles of design and structure, as well as preparation and proper technology of production are similar. At the beginning, the function of machines being designed is tested through a mathematical model of a hoist, which the company developed for its own needs, and on which correctness of designed concept of a designed winding plant is checked, and its behavior in particular operational and emergency modes (starts, braking, security braking in the most adverse cases, critical delays, breakage of a winding rope, etc.).
Frictional discs are designed as split welded constructions. Welding is executed in protective atmosphere, and all weldments of friction disks are annealed after welding with the view of inner stress relief, and are subjected to extensive material tests, by which the quality of welds is proved. The compliance of the mechanical characteristics and chemical structure of the material contained both in the construction documentation and the material used manufacture, are attested and subjected to materiological tests that confirm the homogeneity of the material and eliminate possible hidden flaws. Frictional discs are equipped with grooves for the lining insets. Currently, all frictional hoists are fitted with wedge-split lining insets. All types of frictional lining is delivered on the basis of consumer's choice, however, the most common types are friction insets of the following manufacturers: Becorit K22, K25 (Germany), CRBZAM V1-714, V2-714 (Czech republic), and Modar R3/Mz (Poland).
Brake disks are structurally designed as divided with respect to the technology of production, and especially with respect to the highest operational warming, whereas each of the disks consists of six, or in the case of smaller diameters, of four segments. Only brake disks of the smallest diameters (2000 mm) are made of one-piece (welded to the friction disk structure).

The segments are screwed to thickened side plates of disks using the analogous technology as that used with connecting frictional disk halves (hydraulically tightened screws with defined axial pre-stress). Mutual location of individual segments is stabilized by the help of locks of groove and tongue type. To every brake disk, sensors automatically checking the extent of its axial run-out are installed on mounting.

The sensors signal possible deviation of the disk or its segment. Moreover, every disk is fitted with an infrared sensor, which checks possible overheating of the disk over the permissible limit.
The main shafts are manufactured as shaped, with connectable flanges. For rotor placement we use flange connection, or more often the rotor is placed directly on the main shaft.
Bearings are mostly anti-frictional double-row inclinable spherical roller-bearings. Their lubrication is ensured with the aid of an autonomous microprocessor-controlled system Tribonic III. At customer's request (also during modernizations of older hoists) we use the well-tried sleeve bearings with two-part or four-part bearing basin that are circulatory-lubricated by grease with the aid of an autonomous lubrication system Tribonik MKL. The bearing pedestals are fitted with pressure sensors, or alternatively flow sensors, and thermometers with a remote signaling and marginal contact.

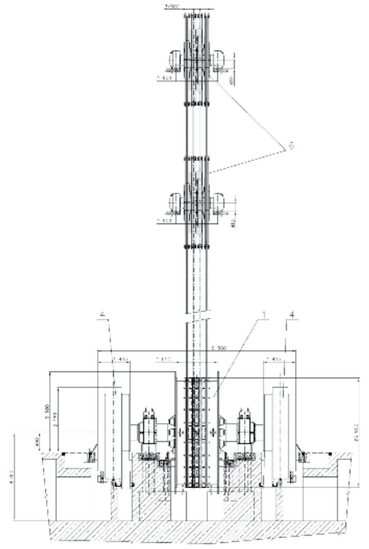


Braking apparatus is formed by modular brake units which are placed on brake pedestals in the necessary amount, acting on usually 2 brake discs. Control of their braking power is hydraulic, and is ensured by any of our electro-hydraulic braking systems types HR9K, HR13K (with a constant braking momentum under the safety-brake mode), Frenomatic HR11K, Reprimatic HR17K. The last two types, thanks to their highly sophisticated hydraulics and electronics, ensure Constant Retardation under the safety brake mode. Electro-hydraulic systems for supply and control of braking units are addressed on a separate catalogue sheet, including the used braking units.

Electric part of the DC-drive hoists (from 750 to 2 x 5500 kW)

A converter is used for power supply of the DC motor. A twelve-pulse reversal connection for armature of direct current motor (converter set VARIANT) with a non-reversal six-pulse reversal converter (converter and regulation set MODULEX) for actuation of direct current motor is used. The converters for armature circuits of the motors are designed in modular arrangement VARIANT, enabling fast exchange of component blocks in case of need.

The component block contains a semiconductor element (thyristor) in the pellet design with coolers on a principle of heat pipes, fuses for protection of thyristor, signaling circuits indicating working conditions of thyristor, and converters of switching pulses. The component



blocks are arranged in VARIANT boxes in layers by three blocks. One layer thus contains a complete three-phase bridge. Cooling of the component blocks is provided by a ventilator located on the top side of the box. Cooling air is sucked through the rear wall of the box through an input filter, blown over cooling ribs of the heat pipes of the component blocks, and exhausted by a ventilator through the top side above the set. The rear part of VARIANT set is accessible after opening the rear door with the air input filter. In this room, strip heavy-current distributions with current sensors are located. The lower part of the front door covers the compartment with auxiliary devices (circuit breakers, power supplies, terminal blocks), and separate the compartment from the power supply circuits of the converter. In the case of another requirement for connection of the converter set Variant to the cable distribution, other construction arrangements may be carried out. Converter sets VARIANT may be installed by placing sidewalls next to each other.
The converters for actuating circuits of direct current motors are designed in modular arrangement of MODULEX sets. The sets contain a modular component block with converter of actuation made up of potential-free thyristor modules, including over-voltage protection, current sensors, converters of switching pulses, and protective fuses. Air cooling of the component block is provided by its own ventilator located inside the box. Cooling air is sucked through the rear wall of the box through an input filter, and blown out through a grid located in the lower part of the front door.