General

Technical Section Y of the catalog contains useful information pertaining to the selection, mounting, alignment and control of clutches and brakes in general. Formulas, symbols and units are also identified. It is recommended that Section Y be reviewed before attempting to size a specific product for an application.

WCB elements are used primarily in applications which must slip for long periods of time. Selection criteria are the dynamic slipping torque and the resulting thermal power, neither of which necessitates the use of service factors.

Like all friction material, the torque developed by water-cooled elements is not perfectly constant at a given air pressure. Once per revolution torque variation and drift over time may occur.

Element Torque Adjustment

WCB dynamic torque ratings $\mathbf{M_r}$ are based upon an effective pressure $\mathbf{p_r}$ of 80 psi (5,5 bar). Maximum allowable operating pressure is 150 psi (10,3 bar). Torque ratings must be adjusted for operating pressure $\mathbf{p_o}$ and parasitic loss $\mathbf{p_p}$.

The elements have an inherent parasitic pressure $\mathbf{p_p}$ required to cause friction disc engagement which represents the pressure to overcome internal sliding friction and to compress disc releasing springs.

No. of Friction Discs	Pressure p_p	
	psi	bar
1	3	0,21
2	4	0,28
3	5	0,34
4	6	0,41

Element torque $\mathbf{M_e}$ is calculated from:

$$M_e = \frac{p_o - p_p}{p_r} \cdot Mr$$

WCS elements are spring-applied, pressure released. Minimum releasing pressure is 80 psi (5,5 bar). Maximum allowable cylinder pressure is 150 psi (10,3 bar). The torque ratings are for new linings. Torque will decrease as lining wears. At the worn out condition, the torque is approximately 0.66 of the new lining condition. Element torque can be regulated by biasing the spring force through control of the minimum releasing pressure and monitoring lining wear.

Thermal Capacity

Thermal capacities are for continuous operation at the coolant flow rate and temperatures indicated. For intermittent duty such as short duration loads or infrequent high inertia stops, the thermal capacities can be increased 50% for periods up to 20 minutes. The coolant flow must be increased accordingly.

Example

What is the dynamic torque capacity of a 224WCB element when used with an operating pressure of 50 psi (3,4 bar)?

$$M_e = \frac{p_o - p_p}{p_r} \cdot Mr$$

$$= \frac{50 - 4}{80} \cdot 20000$$

$$= 115000 \text{ lb·in}$$

Example

What pressure should be applied to a 118WCB element to develop a torque of 60,000 lb·in (6780 N · m)?

$$M_e = \frac{p_o - p_p}{p_r} \cdot Mr$$

$$p_o = \frac{M_e}{M_r} \cdot p_r + p_p$$

$$= \frac{60000}{48000} \cdot 80 + 3$$

$$= 103 \text{ psi}$$

For efficient cooling, an adequate supply of filtered fresh water is required. Excessive water hardness promotes the formation of scale deposits, which in time will affect the service life of the WCB unit. Water of high acidity may cause electrolytic corrosion between the dissimilar metals used in the WCB construction. Water treatment should be considered if the calcium carbonate exceeds 100 ppm. The water pH value should fall between 7.0 and 9.0.

The WCB cooling capacity of 10 HP per gallon per minute (1.97 kW per cubic decimeter per minute) is based on a 50ºF (28ºC) maximum temperature rise of a fresh water coolant. Maximum outlet water temperature should not exceed 150ºF (66ºC).

Maximum ambient temperature limit for the WCB is 110ºF (43ºC). For open loop systems using water, the minimum is 45ºF (7ºC). Minimum ambient temperature limit for closed loop systems using an ethylene glycol coolant is 0ºF (-18ºC).

Maximum allowable inlet coolant pressure is 45 psi (3,1 bar). A relief valve should be incorporated in the inlet manifold to prevent pressure surges.

Ethylene glycol is usually added to cooling water (especially in exposed applications) to prevent freezing. An ethylene glycol coolant conforming to SAE Standard J1034 should be used. For preparation of a water/ethylene glycol mix, water which is low in corrosive ions such as chlorides and sulphates should be used. The mixture's pH value should fall between 7.5 and 10.5. The thermal capacity of a mixture is not as great as that of water alone, so coolant flow must be determined from the values given in the table. Because the boiling point of the mixture is higher, a higher outlet coolant temperature is permissible. Ethylene glycol content of the mixture should not exceed 50% by volume. Larger amounts will reduce cooling capacity and can cause coolant leakage, due to overheating.

English Units		
30	8.5	165
40	7.7	165
50	6.7	170
Ethylene Glycol Mixture % by Volume	HP/GPM	° F
	Flow	Maximum Outlet Temperature
	kW/dm³pM	° C
30	1,67	74
40	1,52	74
50	1,32	77
SI Units		

Sea water can be used as a coolant; however, its thermal capacity is 8 HP per gallon per minute (1.58 kW per cubic decimeter per minute). If sea water is used as a coolant, a 500 micron filter is recommended. After use, coolant cavities must be flushed with fresh (uncontaminated) water.

The coolant values are based on balanced parallel coolant flow through each section of the brake. Series flow is not recommended. Inlet and outlet coolant manifolds must be provided with connecting flexible hoses to each brake section. To insure coolant cavities are filled, inlet ports must be at the six o'clock position.

For intermittent duty under certain conditions, such as short duration loads or infrequent high inertia stops, thermal ratings can be exceeded for limited periods.

Pressure drops for parallel balanced flow across the brake can be determined from:

$$p = C \; F^2$$

where:

p = pressure drop (psi or bar)

C = pressure drop coefficient*

F = flow (gallons/min or dm³/min)

* see WCS technical data section

Example

It is planned to use a 136WCB to handle a thermal load of 300 HP (224 kW). What flow of fresh water is required and what is the pressure drop across the element?

$$GPM = \frac{P_t}{10 \, ^{HP}/_{GPM}}$$

$$= \frac{300}{10}$$

$$= 30$$

$$p = C \quad F^2$$

$$= 2.9 \text{ E -03} \quad 30^2$$

$$= 3 \text{ psi}$$

Liquid to Liquid Coolant System

A typical closed loop liquid to liquid system is shown here. The heat exchanger and its temperature control are replaced by a radiator, fan and motor in a liquid to air system.