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Ricardo Hughes

Plant & Asset Engineering

1)a) - There is various types of corrosion taking place on the 3 images shown.
Firstly ~~wet corrosion is taking place~~. General Corrosion is taking place this is defined as the corrosion which causes uniform loss of wall thickness which takes place over the ~~whole~~ entire surface area of the metal exposed to the same conditions. This type of corrosion is shown as orange caused iron oxide corrosion product on the surface of the steel. This is the result when exposed to elements in the atmosphere. oxidation occurs when water and oxygen react and forms hydrated iron oxide.

- another type of corrosion taking place is dry corrosion, this takes place with the absence of water, this typically takes place at temperatures in excess of 400°C where there is direct chemical oxidation on the surface metal to it metal oxide in the presence of oxygen.
essentially the oxygen has to make contact with the metal surface, as soon as corrosion starts to occur the oxide layer ~~that~~ that forms on the surface it will limit the amount of oxygen that can further react with the metal.

- another type of corrosion taking place is localised corrosion, this is a specific form of corrosion which occurs as certain points on the metal surface. This can be extremly damaging to the structure due to rapid degradation taking place and due to the local nature of the attack. this can pass undetected until failure occurs.

R

Rhoda Hughes

Plant & Asset engineering

1)b) There are various issue that need to be considered with regard to aging electrical control equipment. These systems are employed to provide emergency shutdown systems such as trips and alarms. This either separately or in a combination with other system ensure safety in process plant.
With regard to managing major hazards, it must be clear which of the EC&I systems are safety critical.
These systems can be effected by the same degradation as mechanical equipment, such as corrosion, erosion and fatigue. Although EC+I are subject to specific degradation mechanisms. These including physical impact, damage, or surface abrasion, overheating/burn damage, blockage, fouling or poisoning the formulation of tin whiskers or dry joints.
Another issue is that certain types of instrumentation and control systems can become obsolete or difficult to support. Also poor quality control of plant painting activities can effect the equipment, such as painting flame proof glands or painting over instruments.
To summarise the issues to be considered are: is the equipment ageing, is there an understanding of the safety significance of the equipment, are plans in place to replace the equipment during its life cycle, is there a good maintence plan and the potential to upgrade and is the adequate arrangements for management of change.

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3) a) Reasons why this design typically leads to higher fouling rate is in shell and tube heat exchangers conventional segment baffle geometry is largely responsible for higher fouling rates, This is caused by uneven velocity profiles, ~~eg~~ regurgitation and eddies generated on the shellside of these segmentally baffled heat exchangers. this results in shorter run time between periodic cleaning and maintance of the tube bundles.

b) four mechanisms considered significant factors in fouling:
- Particulate matter in flows
- Crystalisation
- Chemical reaction
- Corrosion processes.

c) The design incorporates quadrant shaped baffel plates that are placed at an angle to the ~~tube~~ tube axis in a sequential arrangement to create a helical flow pattern.
This is improved by:
- ~~Imp~~ uniform flow velocity through the tube and bundle.
- eliminates regurgitation of eddies
- shellside flow tends to be turbulent flow, this improving the temperature driving force.
- higher flow velocities are achieved with lower pressure drops

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Ricardo Hughes

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3) c) Cont) These characteristics contribute significantly in lowering the fouling rate and maintain higher performance during longer operating times, compared to conventional shell & tube heat exchangers.

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4) a) - Both AC & DC motors function of the Principle of electromagnetic induction.
- A 3 Phase (AC) motors is self starting due to the induced magnetic field in the rotor.
A single phase is non self starting and requires additional equipment to start.

b) - The fundamental operation of an AC drive consists of a changed a fixed incoming line voltage (V) and the frequency (Hz) this to a variable voltage and frequency output. The output frequency will then determine the speed in which the motor rotates with the combination of volts & hertz will dictate the amount of torque produced by the motor
- The prime advantage of AC drives is its ability to operate an AC motor in bypass mode, for example when the drive is not functioning, the motor can still operate, thus due to across line power.
The motor will operate at full speed due to the line power input, the result is system continues to operate with little or no downtime. These types of drives require little maintance..

G

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4) c) - The mechanical property relied upon in power transmission using belts and pulleys is friction between the belts and pulleys. When the belts runs over the pully there is always friction which acts between the pully surface and the belt surface in the opposite direction of motion. this essensially transmitting power by friction.

- A dissadvantage of belts & pulleys is belts can/will stretch over time resulting in ~~less~~ slippage and loss of drive power this requiring re tensioning.
- Another dissadvantage is you cannot achieve a constant velocity ~~ratio~~ ratio between driver and driven pully, not ideal for ~~a~~ accurate speed applications.

- another is ~~chain~~ chain and sprocket drive this doesnt suffer from slip and creep during the power transmission operation.

d) - A spur gear is the simplest type of gear it utilizes straight teeth on the outer diameter of the gear which mates and meshes to the other spur gear which are mounted on parrall shafts. these can be combined to create very large gear reductions.
- Helical gears uses teeth that are set at an angle to the gear axis and can engage more gradually between the teeth of the gear when in operation

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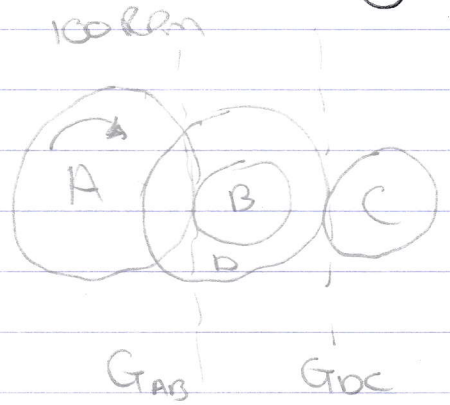
4) d) (en) - Due to the teeth angle it has greater tooth strength and higher load capacity than a spur gear. Therefore it is use in high speed or high load capacity applications such as car gearbox, washing machines and construction equipment

A disadvantage of helical gears is the fact they produce axial thrust that must be accented for due to the engagement.

The addendum is the height of the tooth above the pitch circle. dedendum is the depth of the tooth below the pitch circle these must be the same for the transfer of smooth power between gears.

e) i)



A : 80 teeth
B : 20
C : 20
D = 60

~~$G = \frac{W_A}{W_B} \times \frac{W_D}{W_C}$~~ ~~$W_B = W_D$~~

~~$G = \frac{W_B}{W_A} \times \frac{W_C}{W_D}$~~ $G = \frac{W_C}{W_A}$ $G = \frac{20}{80}$ ~~$G = \frac{1}{4}$~~

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e) i) (cont)

$$G = \frac{\omega_A}{\omega_C} = \frac{t_B}{t_A} \times \frac{t_C}{t_D}$$

$$\frac{\omega_A}{\omega_C} = \frac{20}{80} \times \frac{20}{60} = \frac{1}{12}$$

So if $\omega_A = 100$ RPM ↻

$$\omega_C = \frac{100}{\frac{1}{12}} = 1200 \text{ RPM}$$

ii)

$$\frac{\omega_A}{\omega_C} = \frac{20}{80} \times \frac{20}{60} = \frac{1}{12}$$

i)