

(2)

a) Recording - measuring and recording energy consumption
Analysing - correlating energy consumption to a measured output, such as production quantity

Comparing - Comparing energy consumption to an appropriate ~~standard~~ standard or benchmark

Setting targets - Setting targets to reduce or control energy consumption, these must be sensible and measurable.

Monitoring - Comparing energy consumption to the set target on a regular basis

Reporting - Reporting the results including any variances from the targets which have been set.

Controlling - Implementing management measures to correct any variances, which may have occurred

b) An energy Audit is a study into the energy inputs that the company uses. Such as electric, gas and water for example. ~~From this~~ This identifies all of the ~~costs~~ ~~that~~ ways in which they are used to help visualise the amount of utilities consumed and the inefficiencies that can have a severe impact on the usage. By identifying the inefficiencies and leaks for example it is possible to create an improvement plan that will aim to reduce the amount of utilities used and decrease the cost to the business. These improvements aren't only in the amount of utilities used but also in hidden costs

②

Such as maintenance savings and maximising production hours.

There are different types of energy audit.

preliminary, targeted and comprehensive.

~~what~~ They differ in the amount of depth and coverage they have and selecting an adequate type is important.

(3)

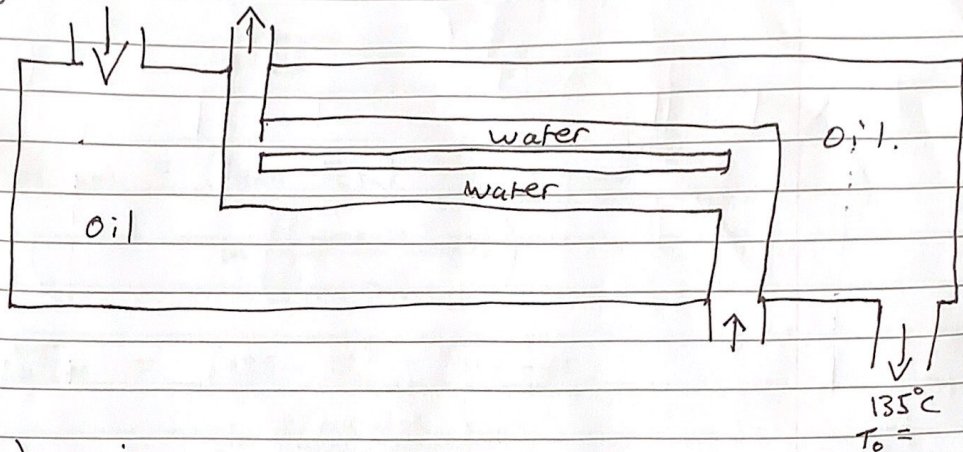
a) ~~The~~ Uneven velocity profiles, regurgitation and eddies generated on the shell side of ~~the~~ a Segmentally-baffled heat exchanger ~~result~~ decrease the running time between periodic maintenance and cleaning of the tube bundles, this increases the operating cost of this form of heat exchanger.

- b)
- 1) Crystallisation
 - 2) Chemical reaction
 - 3) Corrosion
 - 4) Biological mass ~~at~~ accumulation.

- c)
- Uniform flow velocity reducing fouling and creating a uniform temperature distribution.
 - Higher flow velocities are achieved with lower pressure drops, this improves the shear stress at the transfer surface.
 - Reduced shell sizes offer higher tubeside velocities as well as reducing fouling.
 - Elimination of regurgitation and eddies.

d)
i)

$$T_i = 165^\circ\text{C}$$



ii) $\dot{Q} = \dot{m} c_p \Delta T$

$$\dot{Q} = (0.95)(2350)(30)$$

$$\dot{Q} = \underline{66.975 \text{ kW}}$$

iii) $\dot{Q} = \dot{m} c_p \Delta T$

$$\dot{m} = \frac{\dot{Q}}{c_p \Delta T}$$

$$\dot{m} = \frac{66975}{(4180)(45)}$$

$$\dot{m} = \underline{0.356 \text{ kg s}^{-1}}$$

iv) $\dot{Q} = U A F \Delta T_{LM}$ $U = \frac{66975}{(350)(1)}$

~~$U = \frac{\dot{Q}}{A F \Delta T_{LM}}$~~

$$IV) \quad \dot{Q} = UAF\Delta T_{Lm}$$

$$A = \frac{\dot{Q}}{U F \Delta T_{Lm}}$$

$$\Delta T_{Lm} = \frac{(T_{Hout} - T_{Cin}) - (T_{Hin} - T_{Cout})}{\ln \left(\frac{(T_{Hout} - T_{Cin})}{(T_{Hin} - T_{Cout})} \right)}$$

$$\Delta T_{Lm} = \frac{(135 - 15) - (165 - 60)}{\ln \left(\frac{(135 - 15)}{(165 - 60)} \right)}$$

$$\Delta T_{Lm} = 112.33$$

$$A = \frac{66975}{(350)(1)(112.33)}$$

$$A = 1.704 \text{ m}^2 \text{ 3.d.p.}$$

(4)

a) Both AC and DC Motors rely on electro magnetic fields to spin the motor.

3-phase differ as they have the ability to self start.

b) Firstly the incoming AC power is converted to DC power. Then by using capacitors the supply is smoothed out so it can be fed back to AC at the desired voltage and frequency in order to get the desired motor speed. This control over the motor's speed is the key benefit over DC motor drives as it is more controllable for a process needs.

c) belt pulleys rely on friction between the pulley and the belt in order to transfer the rotational forces but due to this friction wear is a problem as well as lack of friction causing slippage and a loss of drive or alignment.

V-belts were designed to overcome slippage issues with flat belts. Chain drive systems ~~increased the~~ decreased the wear issue as well as the slippage issue.

- d) Spur gears have straight teeth that mesh to corresponding teeth on a second gear on a parallel shaft. In contrast helical gears have teeth that are set at angle to the gear axis so that the mesh gradually.

~~Spur gear Advantage~~

↳ Simplicity makes them

Simplicity is the main advantage for spurgears, they are easy to design, manufacture and install. On the down side they can be noisy and offer more vibration at higher speeds.

Helical spur gears are quieter at higher speeds due to there gradual meshing as well as smoother.

They also have a higher tooth strength and load carrying capacity. Disadvantages are they are more complex to make and install, but they also create axial thrust as they engage so they need to be fixed in place.

Applications:

Spur gears:

- ↳ clocks
- ↳ pumps.
- ↳ material handling equipment.

helical gears:

- ↳ Vehicle transmissions
- ↳ blenders
- ↳ construction equipment
- ↳ fuel pumps.

For both types the number of teeth ^{depth.} must match
 For both types the teeth dimensions must match
 so that they mesh correctly and don't damage each other.

e)
i)

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

$$G = \frac{20}{80} \times \frac{20}{60}$$

$$G = \frac{1}{12}$$

$$G = \frac{\omega_A}{\omega_C} \quad \omega_C = \frac{\omega_A}{G}$$

$$\therefore \omega_C = \frac{100}{\frac{1}{12}}$$

$$\omega_C = 1200 \text{ rpm}$$

$$\text{ii)} \quad G = \frac{20}{80} \times \frac{20}{60}$$

$$G = \frac{1}{12} \quad \text{or } 1:12.$$

iii)