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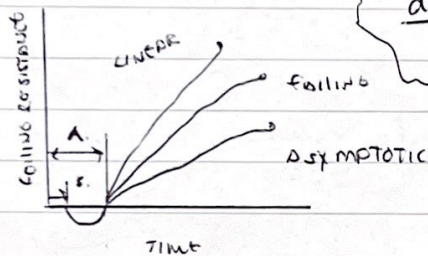
27/05/22.

PLANT 4 ASSET EXAM.

Kaine Angus.

Q3.

- a.) "SHELLSIDE SHELL & TUBE HEAT EXCHANGER. USES WATER TO COOL OIL. OIL IS THE SHELL SIDE MEDIUM WHIST WATER IS THE TUBE SIDE MEDIUM. THE OIL ENTERS THE TOP & FLOWS THROUGH THE HEAT EXCHANGER UNTIL REACHING THE BOTTOM DISCHARGE, WATER FLOWS THROUGHT THE TUBES FROM THE RIGHT INLET TO THE LEFT DISCHARGE. FOULING RATES ENHANCE PRESSURE LOSS & EXTENDED PUMPING POWER, THE ACCUMULATION OF UNDESIRABLE SUBSTANCES IS DEFINED AS FOULING.



$$\frac{dm_f}{dt} = m_d - m_r$$

m_d & m_r ARE NOT DEPOSITION RATES
DEPOSITION & REMOVAL RATES RESPECTIVELY.

A = ROUGHNESS DELAY TIME.

B = INITIATION PERIOD.

THE INCREASED OPERATING COSTS WOULD BE DUE TO THE HEAT EXCHANGER REQUIRING MAINTENANCE DUE TO THE FOULING & ALSO WOULD NEED TO BE REMOVED FROM SERVICE FOR CLEANING OR REPLACEMENT. A METHOD TO CLEAN IN SITU WOULD BE TO CHEMICALLY FLUSH THE PIPES TO CLEAR ANY BLOCKAGES.

b.) SIGNIFICANT FACTORS IN THE DEVELOPMENT IN FOULING:

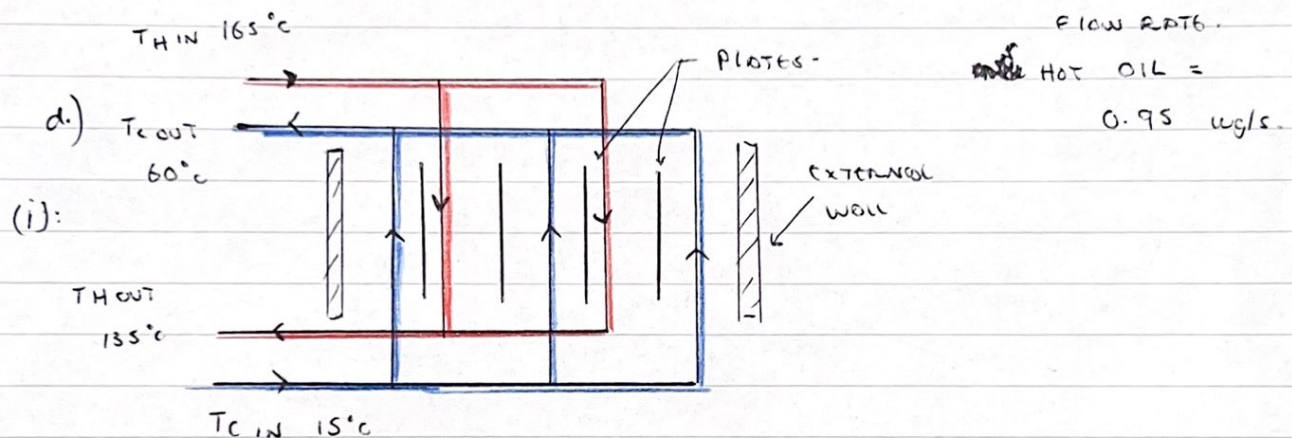
- 1.) CORROSION IN THE PIPES.
- 2.) ACCUMULATION OF DIRT IN THE PIPES NOT CAPTURED BY THE STRAINER
- 3.) ACCUMULATION OF BIOLOGICAL MATERIAL.
- 4.) CHEMICAL FOULING.

(2.)

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Q 3(c): Helical baffles affect the shell side flow characteristics as they support the tubes during assembly & operation which help prevent vibration from induced forces. They direct the shell side fluid back & forth across the tube bundle to provide effective velocity & heat transfer rates. This directs the flow in the shell & tube sides such that the fluid velocity increases sufficiently to reach a high heat transfer coefficient & also reduces fouling. This overall will improve the performance of the heat exchanger on site.



(i):

$$\begin{aligned}\dot{Q}_H &= \dot{m}_H \cdot C_{pH} \cdot (T_{HIN} - T_{HOUT}) \\ &= 0.95 \cdot 2350 \cdot (165 - 135) \\ &= \underline{\underline{66.78 \text{ kW}}}\end{aligned}$$

(iii):

$$\dot{m}_C = \frac{\dot{Q}_C}{C_{pC} (T_{COUT} - T_{CIN})} \quad \text{WHERE, } \dot{Q}_C = \dot{Q}_H$$

$$\therefore \dot{m}_C = \frac{66.78 \times 10^3}{4180 \cdot (60 - 15)} = \underline{\underline{0.36 \text{ kg/s}}}$$

(3)

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(iv): $\dot{Q} = U.A.F. \Delta T_{LM}$ WHERE $F < 1$ FOR COUNTER
FLOW HX.

$$\therefore A = \frac{\dot{Q}}{U.F. \Delta T_{LM}} \quad \Delta T_{LM} = \frac{\Delta T_o - \Delta T_i}{\ln \left(\frac{\Delta T_o}{\Delta T_i} \right)}$$

$$\begin{aligned} \Delta T_o &= T_{H \text{ OUT}} - T_{C \text{ IN}} \\ &= 135 - 15 \\ \Delta T_o &= 120^\circ \text{C}. \end{aligned}$$

$$\begin{aligned} \Delta T_i &= T_{H \text{ IN}} - T_{C \text{ OUT}} \\ &= 165 - 60 \\ &= 105^\circ \text{C}. \end{aligned}$$

$$\therefore \Delta T_{LM} = \frac{120 - 105}{\ln \left(\frac{120}{105} \right)} = 112.33 \text{ K}.$$

$$A = \frac{66.98 \times 10^3}{350 \times 1 \times 112.33} = \underline{1.704 \text{ m}^2}.$$

4.

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Q1:

(a) WHAT TYPES OF CORROSION & WHAT CAUSES THEM TO HAPPEN.

UNIFORM CORROSION: IS CONSIDERED TO BE AN EVEN ATTACK ACROSS THE SURFACE OF A MATERIAL & IS THE MOST COMMON TYPE. IT IS ALSO THE MOST BENIGN AS THE EXTENT OF THE ATTACK IS RELATIVELY EASILY JUDGED, & THE RESULTING IMPACT ON MATERIAL PERFORMANCE IS FAIRLY EASILY EVALUATED DUE TO THE ABILITY TO CONSTANTLY REPRODUCE & TEST THE PHENOMENON.

PITTING CORROSION: IS ONE OF THE MOST DESTRUCTIVE TYPES OF CORROSION, AS IT CAN BE HARD TO PREDICT, DETECT & CHARACTERISE. PITTING IS A LOCALISED FORM OF CORROSION IN WHICH EITHER A LOCAL POINT OR MORE COMMONLY A CATHODIC POINT, FORMS A SMALL CORROSION CELL WITH THE SURFACE SURROUNDING A NORMAL SURFACE. ~~ONCE~~ ^{ONCE} A PIT HAS INITIATED, IT GROWS INTO A "HOLE" OR "CAVITY" THAT TAKES ON ONE OF A VARIETY OF DIFFERENT SHAPES. PITS TYPICALLY ~~REPRODUCTION~~ PENETRATE FROM THE SURFACE DOWNWARDS IN A VERTICAL DIRECTION. PITTING CORROSION CAN BE CAUSED BY A LOCAL BREAK OR DAMAGE TO THE PROTECTIVE OXIDE FILM OR A PROTECTIVE COATING. PITTING IS DANGEROUS BECAUSE IT CAN LEAD TO FAILURE OF THE STRUCTURE WITH A RELATIVELY LOW OVERALL LOSS OF METAL.

GALVANIC CORROSION: IS THE DEGRADATION OF ONE METAL NEAR A JOINT OR JUNCTION THAT OCCURS WHEN TWO ELECTROCHEMICALLY DISSIMILAR METALS ARE IN ELECTRICAL CONTACT IN AN ELECTROLYTIC ENVIRONMENT, FOR EXAMPLE WHEN COPPER IS IN CONTACT WITH STEEL IN A SALTWATER ENVIRONMENT. HOWEVER, EVEN WHEN THESE CONDITIONS ARE SATISFIED THERE ARE MANY OTHER FACTORS THAT AFFECT THE AMOUNT OF CORROSION SUCH AS TEMP, & SURFACE FINISH OF THE METALS.

5.

Handouts

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PITTING CORROSION CAN BE CAUSED BY DAMAGE OR A BREAK IN THE OXIDE FILM OR A PROTECTIVE COATING CAN BE CRACKED THROUGH NON-UNIFORMITIES IN THE STRUCTURE OF THE METAL. THIS DANGEROUS FORM OF CORROSION CAN CAUSE A STRUCTURE TO FAIL.

GALVANIC CORROSION, GALVANIC SERIES DETERMINES WHICH METAL CORRODES FASTER, WHICH IS USEFUL WHEN USING A SACRIFICIAL ANODE TO PROTECT A STRUCTURE FROM CORROSION.

6.

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27/03/22.

Q2:

(a.) ENERGY MONITORING & TARGETING IS PRIMARILY A MANAGEMENT TECHNIQUE THAT USES ENERGY INFORMATION AS A BASIS TO ELIMINATE WASTE, REDUCE & CONTROL CURRENT LEVEL OF ENERGY USE & IMPROVE THE EXISTING OPERATION PROCEDURES. IT BUILDS ON THE PRINCIPLE "YOU CANT MANAGE WHAT YOU DONT MEASURE". THIS COMBINES THE PRINCIPLES OF ENERGY USE & STATISTICS.

MONITORING IS AIMED AT ESTABLISHING THE EXISTING PATTERN OF ENERGY CONSUMPTION, TARGETING IS THE IDENTIFICATION OF ENERGY CONSUMPTION LEVEL WHICH IS DESIRABLE AS A MANAGEMENT GOAL TO WORK TOWARDS ENERGY CONSERVATION.

MONITORING & TARGETING IS A MANAGEMENT TECHNIQUE IN WHICH ALL PLANT & BUILDING UTILITIES SUCH AS FUEL, STEAM, REFRIGERATION, COMPRESSED AIR, WATER & ELECTRICITY ARE MANAGED AS CONTROLLABLE RESOURCES IN THE SAME WAY. THAT RAW MATERIALS, FINISHED PRODUCT, BUILDING OCCUPANCY, PERSONNEL & CAPITAL ARE MANAGED. IT INVOLVES SYSTEMATIC DISCIPLINED DIVISION OF THE FACILITY INTO ENERGY COST CENTRES. THE UTILITIES USED IN EACH CENTRE ARE CLOSELY MONITORED & THE ENERGY USED IS COMPARED WITH PRODUCTION VOLUME. ONCE THIS INFORMATION IS AVAILABLE ON A REGULAR BASIS, TARGETS CAN BE SET, VARIANCES CAN BE SPOTTED & INTERPRETED, & REMEDIAL ACTIONS CAN BE TAKEN & IMPLEMENTED.

THE ELEMENTS OF MONITORING & TARGETING SYSTEM:

- RECORDING - MEASURING & RECORDING ENERGY CONSUMPTION.
- ANALYSING - CORRELATING ENERGY CONSUMPTION TO A MEASURED OUTPUT.
- COMPARING - COMPARING ENERGY CONSUMPTION TO A STANDARD.
- SETTING TARGETS - TO REDUCE OR CONTROL.
- MONITORING - COMPARE TO A SET TARGET ON REGULAR BASIS.
- REPORTING - VARIANCES FROM THE TARGETS.
- CONTROLLING - IMPLEMENTING MANAGEMENT MEASURES.

Kaine Angus 27/05/2022:

Q 2. (B.)

An energy audit is completed at a residential or commercial building to determine its energy efficiency. Simply put, energy efficiency means using less energy to do the same job. The audit will provide you with a complete electricity consumption and energy efficiency assessment. You can obtain important information regarding your energy usage and Energy Star rating from the audit report. With this information, you can identify and correct any energy usage issues to cut electricity costs. It's advisable to always undertake an energy audit before implementing a renewable energy system. A registered energy advisor or energy auditor will conduct a home energy audit or business energy audit. In addition, energy auditors are responsible for completing energy efficiency assessments of commercial and non-commercial buildings.

There are three parts to an energy audit: evaluation, testing, and efficiency recommendations. Once the audit is complete, the auditor will provide you with a report outlining energy consumption, a final energy grading, and home improvement suggestions to cut energy costs on energy bills.

Part One: The Evaluation

A registered energy auditor will come to your home or business and conduct a walk-through of the inside and outside to determine your energy usage and problem areas. While conducting their walk-through, they will analyse specific elements that contribute to your home's or business's overall energy efficiency. The auditor will analyse the heating and cooling systems, or HVAC system, and your insulation levels, including the basement and exterior attic walls. In addition, they will measure and count how many doors and windows the building has and take external measurements.

Part Two: Airtightness And Other Tests

The second part of an energy audit involves an airtightness test, also known as a blower door test. During this test, an energy auditor will determine how tight a building's envelope is by checking for air leakage in a house or business. During an airtightness test, an air sealing procedure is done. The auditor will seal the front door of the building, and they will place a large fan inside.

The testing fan will pull the interior air outside the building, which will force outside air to come through any cracks or holes. Often, these air leaks are easily felt with your hand, but most auditors will use feathers or incense to accurately determine where the cracks are located. In addition to the airtightness test, an energy auditor will assess your business or home's energy use by conducting a thermographic scan. Moreover, they will use various energy usage equipment items to measure energy consumption, such as infrared cameras, surface thermometers, and furnace efficiency meters. Finally, the auditor will analyse past utility bills.

Part Three: Recommendations to Improve Energy Efficiency

Once your residential or commercial building has been evaluated and testing has been completed, the energy auditor will provide you with a thorough list of recommendations regarding energy efficiency improvements you can undertake. If implemented, most of the recommendations will help you save money on utility bills.