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Auxiliary Power Saving In Air Cooled Steam Condenser by Pumps (A Heat Exchanger Used In Steam Power Plant)

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Abstract- Water demand from thermal power plants, mainly for steam condensation (power plant cooling) can place a significant burden on limited local and regional freshwater supplies. An approach to reducing this cooling water demand is the use of direct dry cooling, which requires no consumptive water use and can reduce a power plants water demand by up to 95 percent. Direct dry cooling uses air-cooled steam condensers which consist of a series of finned, air-cooled condenser tubes arranged in an A-frame configuration. Steam is routed from the steam turbine to the condenser, where the heat from the condensing steam is rejected to the environment via the finned tubes. Beneath these condenser tubes is an array of fans, which force a stream of air through the condenser. A major limitation to using this cooling technology is that air-cooled steam condensers are unable to maintain their performance during very hot and/or windy periods. This directly affects energy production because a reduction in condenser performance creates backpressure on the steam turbine and reduces electricity generation. The whole world is in the grip of energy crisis and the pollution manifesting itself in the spiraling cost of energy and uncomforted due to increase in pollution as well as the depletion of conventional energy resources and increasing curve of pollution elements. To meet these challenges one way is to check growing energy demand but that would show down the economic growth as first step and to develop nonpolluting energy conversion system as second step. It is commonly accepted that the standard of living increases with increasing energy consumption per capita. Any consideration of energy requirement and supply has to take into account the increase conservation measures. On the industrial font, emphasis must be placed on the increased with constant effort to reduce energy consumption. Fundamental changes in the process, production and services can affect considerable energy saving without affecting the overall economy. It need not be over emphasized that in house hold commercial and industrial use of energy has considerable scope in energy saving. Attempt at understanding the integrated relationship between environment and energy have given shape due to development of R-134a, (an non pollutant refrigerant) to emerging discipline of environmental management. The government of India has laid down the policy "it is imperative that we carefully utilize our renewal (i.e., non-decaying) resources of soil water, plant and animal live to sustain our economic development" our exploration or exploitation of these is reflected in soil erosion, salutation, floods and rapid destruction of our forest, floral and wild life resources. The depletion of these resources often tends to be irreversible since bulk of our population depends on these natural. Pumping systems account for nearly 20% of the world's electrical energy demand and range from 25-50% of the energy usage in certain industrial plant operations (US DOE, 2004).
Pumps have two main purposes:
Transfer of liquid from one place to another place
Circulate liquid around a system
Keywords- Condenser, pump, water, power, energy

I. INTRODUCTION

An air-cooled steam condenser system starts at the turbine exhaust flange. It includes all of the equipment necessary to condense the steam and return the condensate to the boiler feed water piping. These items are: Fan ,Motor ,Pump, Gear ETC

We want to achieve by pumps

A. Pumping System Characteristics

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1) Resistance of the system: head

Pressure is needed to pump the liquid through the system at a certain rate. This pressure has to be high enough to overcome the resistance of the system, which is also called "head". The total head is the sum of static head and friction head:

a) *Static head:* Static head is the difference in height between the source and destination of the pumped liquid Static head consists of:

Static suction head (h_S): resulting from lifting the liquid relative to the pump center line.

The h_S is positive if the liquid level is above pump centerline, and negative if the liquid level is below pump centerline (also called "suction lift)

Static discharge head (h_d): the vertical distance between the pump centerline and the surface of the liquid in the destination tank.

b) *Friction head (h_f)*

This is the loss needed to overcome that is caused by the resistance to flow in the pipe and fittings. It is dependent on size, condition and type of pipe, number and type of pipe fittings, flow rate, and nature of the liquid. The friction head is proportional to the square of the flow rate as shown in figure 3. A closed loop circulating system only exhibits friction head (i.e. not static head).

B. Pump Suction Performance (NPSH)

Cavitation or vaporization is the formation of bubbles inside the pump. This may occur when at the fluid's local static pressure becomes lower than the liquid's vapor pressure (at the actual temperature). A possible cause is when the fluid accelerates in a control valve or around a pump impeller. Vaporization itself does not cause any damage. However, when the velocity is decreased and pressure increased, the vapor will evaporate and collapse.

This has three undesirable effects:

Erosion of vane surfaces, especially when pumping water-based liquids

Increase of noise and vibration, resulting in shorter seal and bearing life

Partially choking of the impeller passages, this reduces the pump performance and can lead to loss of total head in extreme cases.

The Net Positive Suction Head Available (NPSHA) indicates how much the pump suction exceeds the liquid vapor pressure, and is a characteristic of the system design. The NPSH Required (NPSHR) is the pump suction needed to avoid cavitation, and is a characteristic of the pump design.

II. TYPES OF PUMPS

This section describes the various types of pumps. Pumps come in a variety of sizes for a wide range of applications. They can be classified according to their basic operating principle as dynamic or positive displacement pumps -

Positive Displacement pump- Rotary and Reciprocating pump

Dynamic Pump- Centrifugal pump

In principle, any liquid can be handled by any of the pump designs. Where different pump designs could be used, the centrifugal pump is generally the most economical followed by rotary and reciprocating pumps. Although, positive displacement pumps are generally more efficient than centrifugal pumps, the benefit of higher efficiency tends to be offset by increased maintenance costs.

A. Positive Displacement Pumps

Positive Displacement pumps are distinguished by the way they operate; liquid is taken from at one end & positively discharge at the other end for every revolution. Positive displacement pumps are widely used for pumping the fluids other than water. Positive displacement pumps are further classified based upon the mode of displacement:

1) Reciprocating Pump: if the displacement is by reciprocation of a piston plunger. Reciprocating pumps are used only for pumping viscous liquids and oil wells.

2) Rotary pumps: if the displacement is by rotary action of a gear, cam or vanes in a chamber of diaphragm in a fixed casing. Rotary pumps are further classified such as internal gear, external gear, lobe and slide vane etc. These pumps are used for special

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services with particular conditions existing in industrial sites .In all positive displacement type pumps, a fixed quantity of liquid is pumped after each revolution. So if the delivery pipe is blocked, the pressure rises to a very high value, which can damage the pump.

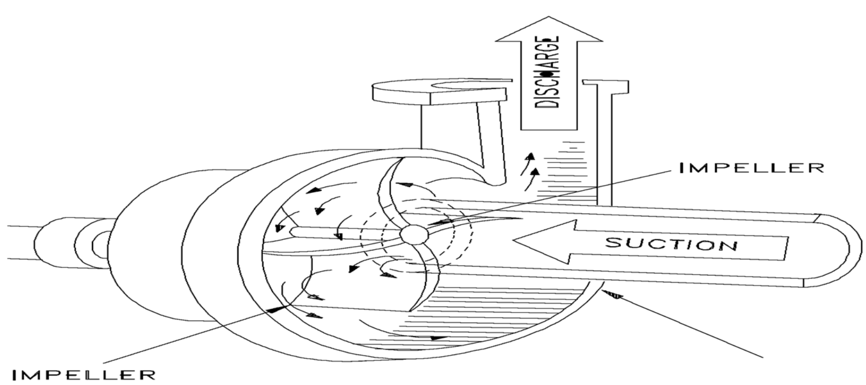
B. Dynamic Pumps

Dynamic pumps are also characterized by their mode of operation: a rotating impeller converts kinetic energy into pressure or velocity that is needed to pump the fluid.
There are two types of dynamic pumps:

*1) Centrifugal Pumps***:** are the most common pumps used for pumping water in industrial applications. Typically, more than 75% of the pumps installed in an industry are centrifugal pumps. For this reason, this pump is further described below.

a) How a Centrifugal Pump Works

A centrifugal pump is one of the simplest pieces of equipment in any process plant. Figure 8 shows how this type of pump operates: Liquid is forced into an impeller either by atmospheric pressure, or in case of a jet pump by artificial pressure. The vanes of impeller pass kinetic energy to the liquid, thereby causing the liquid to rotate. The liquid leaves the impeller at high velocity. The impellers are surrounded by a volute casing or in case of a turbine pump a stationary diffuser ring. The volute or stationary diffuser ring converts the kinetic energy into pressure energy. Centrifugal pump The centrifugal pump creates an increase in pressure by transferring mechanical energy from the motor to the fluid through the rotating impeller. The fluid flows from the inlet to the impeller centre and out along its blades. The centrifugal force here by increases the fluid velocity and consequently also the kinetic energy is transformed to pressure. Centrifugal pumps basically consist of a stationary pump casing and an impeller mounted on a rotating shaft. The pump casing provides a pressure boundary for the pump and contains channels to properly direct the suction and discharge flow. The pump casing has suction and discharge penetrations for the main flow path of the pump and normally has small drain and vent fittings to remove gases trapped in the pump casing or to drain the pump casing for maintenance. A simplified diagram of a typical centrifugal pump that shows the relative locations of the pump suction, impeller, volute, and discharge. The pump casing guides the liquid from the suction connection to the center, or eye, of the impeller. The vanes of the rotating impeller impart a radial and rotary motion to the liquid, forcing it to the outer periphery of the pump casing where it is collected in the outer part of the pump casing called the volute. The volute is a region that expands in cross-sectional area as it wraps around the pump casing. The purpose of the volute is to collect the liquid discharged from the periphery of the impeller at high velocity and gradually cause a reduction in fluid velocity by increasing the flow area. This converts the velocity head to static pressure. The fluid is then discharged from the pump through the discharge connection.



Centrifugal Pump

*2) Special Effect Pumps***:** are particularly used for specialized conditions at an industrial site.

III. PUMPS IN PARALLEL TO MEET VARYING DEMAND

Operating two pumps in parallel and turning one of when the demand is lower, can resulting significant energy savings. Pumps

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providing different flow rates can be used. Parallel pumps are an option when the static head is more than fifty percent of the total head. Figure15 shows the pump curve for a single pump, two pumps operating in parallel and three pumps operatinginparallel.It also shows that the system curve normally does not change byrunningpumpsinparallel.Theflowrateislowerthanthesumoftheflowratesofthe different pumps.

Total power consumption as per power plant condenser

S.No	Power consumpation equipment	Unit	Data
1	Fan Motor	Kw	501
2	CEP Motor(CEP)(for one pump)	Kw	77.35
3	Hotwell Motor(HWT)(for one pump)	Kw	2.15
		Total	580.5

			Data as per horizotal pump requirement.
1	Type		CEP
2	Discharge capacity	m^3/hr	190
3	Head developed	m	160
4	Qty Required	Nos	1

Comparsion of horizotalvs verticals pumps(Cep+HWT)

			Horizotal		Veritcal
1	Type		CEP		CEP
2	Make		Sulzer		Grundfos
3	Pump Model		ZE 100-4400		CR 64-7
4	Quantiy		1		3
5	Discharge capacity	m^3/hr	190		64.3 per pump (3 NosX 64.3 =193)
6	Head developed	m	160		163
7	Pump input power	kW	160		45(3 Nos X 45=135)
8	Total Power consumpation(3 Nos)	kW	160		135

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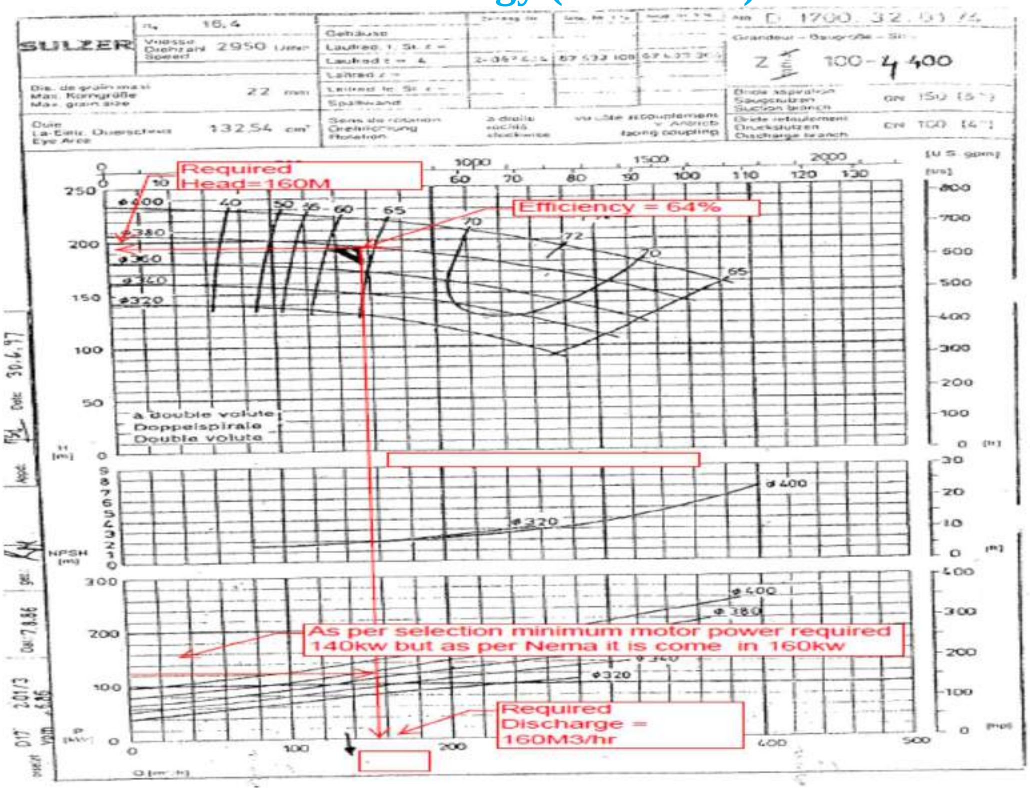

1.	Manufacturer	As per approved vendor list Sulzer Pumps	
2.	Mounting/Type	Horizontal / Centrifugal type.	
3.	Model & Type / Curve No	ZF100-4400 / D1700.32.01/4	
4.	Mechanical seal Details	Supplier to furnish drawing and material specification along with make.	
5.	Discharge Flow	200 m³/hr	Eff = 69 %.
6.	Minimum Continuous Flow	m³/hr	[illegible] 126.36 kw
7.	Discharge Pressure	160 mWC	Sp Gr = 1.00
8.	Suction Pressure	0.15 ata	BKW(L10) = 126.36
9.	Vapour Pressure	0.134 bar	Motor = 160 Kw.
10.	NPSH (Available)	3.5 m	Max power = 163 kw
11.	Process Temperature	52 °C	Rated imp Dia = 350 mm
12.	Hydro Test pressure	(1.5 times of shut off head)	SOH = 180 m
13.	Operating Medium	Condensate Water	
14.	Casing mounting	Foot mounted	
15.	Suction/ Delivery Sizes	[illegible]	150 / 100
16.	Lubrication		Oil.
17.	Direction of rotation (From coupling end)		CW.
18.	Flange Drilling	As per ANSI B 16.5	
19.	Material of Construction: -		
20.	a) Casing	ASTM A-216 WCB	NPSH(R) = 2.3 m
21.	b) Impeller	CA6NM	
22.	c) Shaft	AISI TYPE 410	
23.	d) Shaft Wearing Ring	C6NM	
24.	Speed (RPM)	2950	
25.	Power absorbed	126.36 kw	
26.	Motor recommended	160 KW / 2 Pole	At Rated Condition.
27.	Pump GD^2 value		
28.	Impeller Shaft Diameter		
29.	Bearing Load (min) Radial, Thrust		
30.	Design Ambient temperature:	35 °C	
31.	Quantity Required	2 Nos. (1 Stand By + 1 Operating)	

MAWP = 27 kg/cm²
Hyd. Test P. = 40 kg/cm²
Pump MCF = 80 m³/hr

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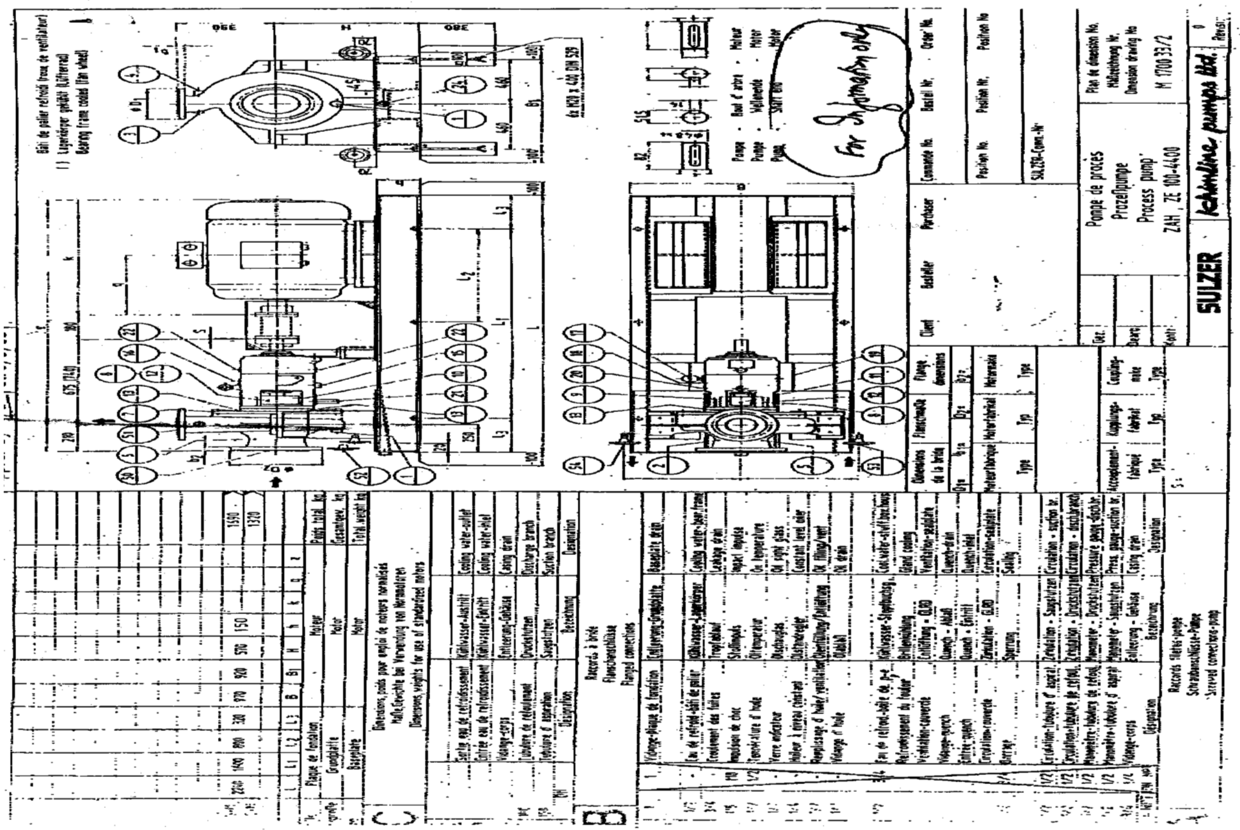


Position	Qty.	Description	Single Price
	1	CR 64-7 A-F-A-E HQQE	Price on request

Note! Product picture may differ from actual product

Product No.: 96123545
Vertical, non-self-priming, multistage, in-line, centrifugal pump for installation in pipe systems and mounting on a foundation.

The pump has the following characteristics:
- Impellers and intermediate chambers are made of Stainless steel DIN W.-Nr. 1.4301 DIN W.-Nr..
- Pump head and base are made of Cast iron.
- The shaft seal has assembly length according to EN 12756.
- Power transmission is via cast iron split coupling.
- Pipework connection is via DIN flanges.

The motor is a 3-phase AC motor.

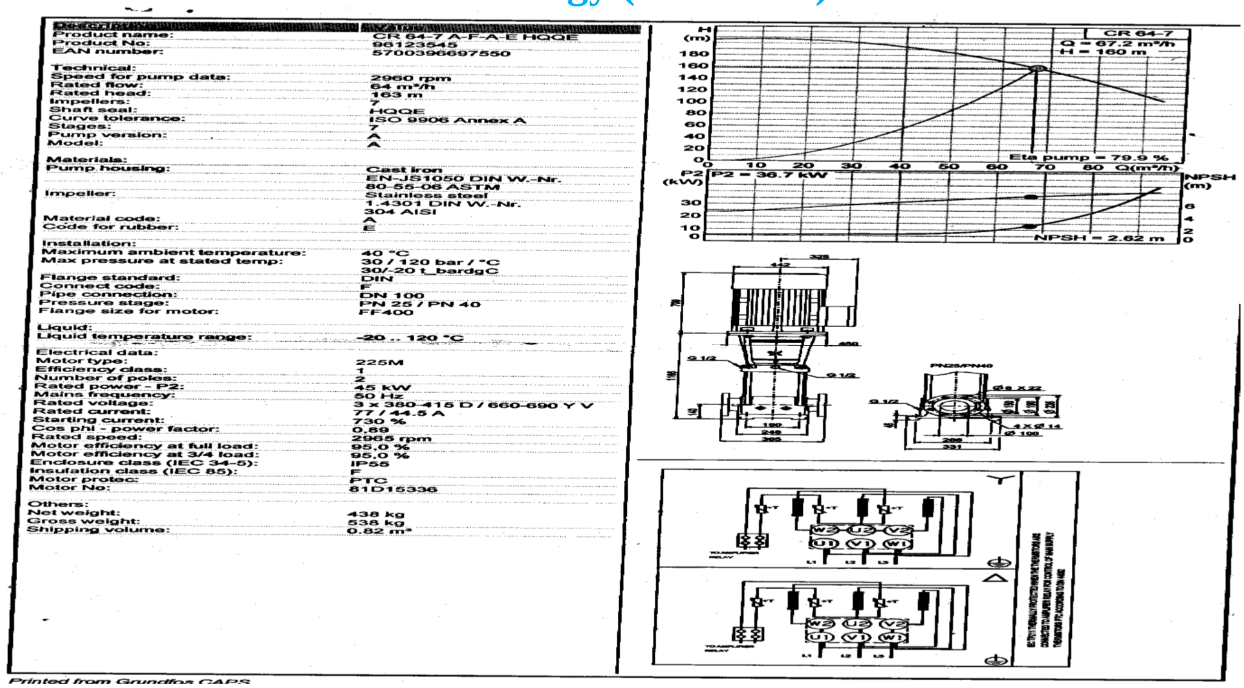
Liquid:
Liquid temperature range: -20 .. 120 °C

Technical:
Speed for pump data: 2960 rpm
Rated flow: 64 m³/h
Rated head: 163 m
Shaft seal: HQQE
Curve tolerance: ISO 9906 Annex A

Materials:
Pump housing: Cast iron EN-JS1050 DIN W.-Nr. 80-55-06 ASTM
Impeller: Stainless steel 1.4301 DIN W.-Nr. 304 AISI

Installation:
Maximum ambient temperature: 40 °C
Max pressure at stated temp: 30 / 120 bar / °C
30/-20 t_bardgC
Flange standard: DIN
Pipe connection: DN 100
Pressure stage: PN 25 / PN 40
Flange size for motor: FF400

Electrical data:
Motor type: 225M
Efficiency class: 1
Number of poles: 2
Rated power - P2: 45 kW
Mains frequency: 50 Hz
Rated voltage: 3 x 380-415 D / 660-690 Y V



IV. CONCLUSIONS

Besides the characteristics of the pump itself, there are certainly other factors which influence the choice of pumping equipment, not the least of which is the design and configuration of the plant equipment and layout, with which the pump must be coordinated. Other factors such as safety regulations will affect the choice of pumping equipment. For example, in order to avoid side outlets in the storage tank it is normally good safety practice on above ground tanks to use vertical we pit pumps.But even where well defined factors such as these do not pre-determine the choice of pump types, it is a mistake to make any hard and fast rules about the selection of a horizontal over a vertical or vice versa. Often in marginal cases, where new equipment is being considered, it would be expedient to obtain quotations on both horizontal and vertical types. Each application must be judged on its won merits, keeping in mind the basic advantages and disadvantages of each type,

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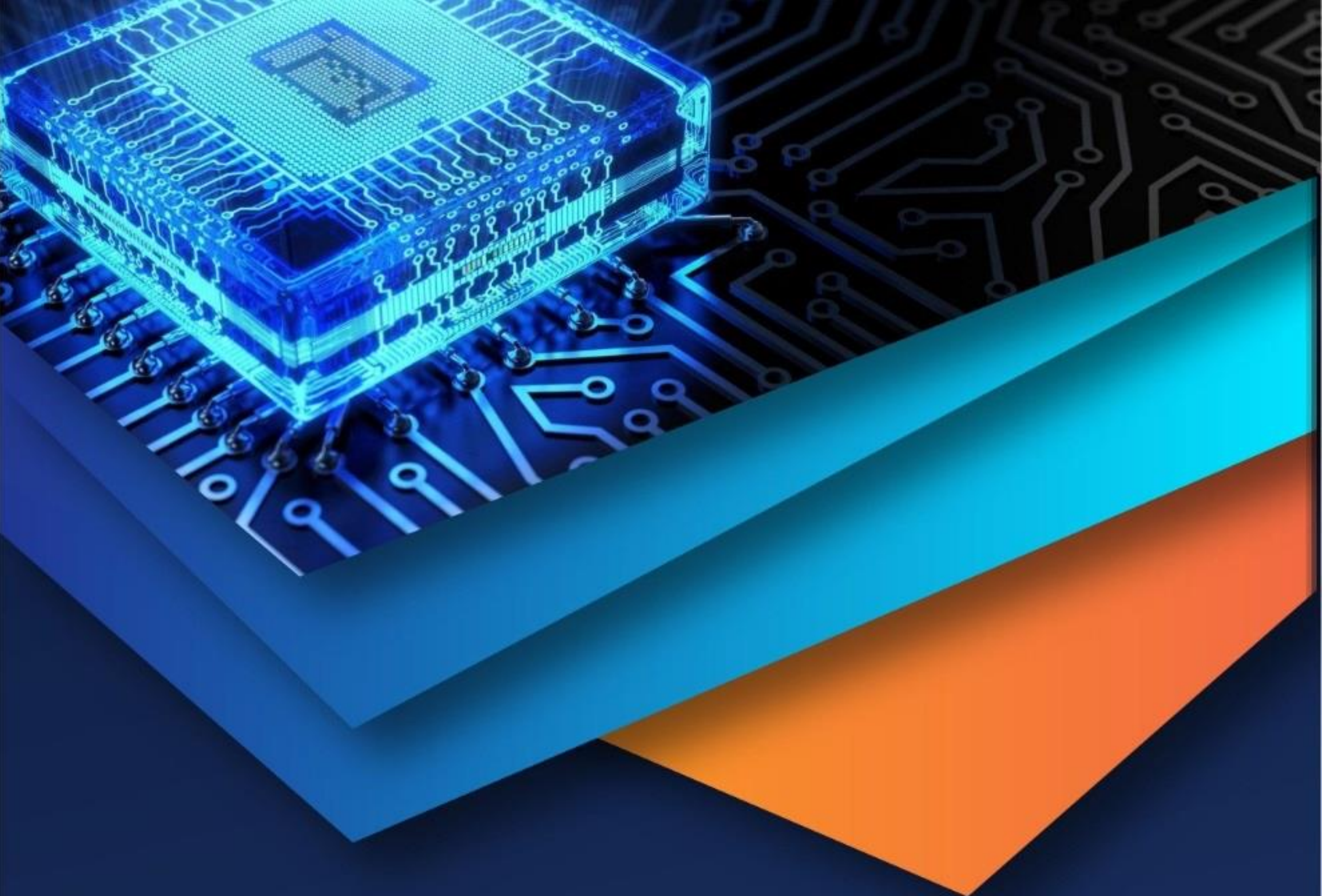

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