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OPTIMIZING AND IMPROVEMENT OF HEAT TRANSFER RATE ON AC EVAPORATOR

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ABSTRACT:
The main objective is to design, develop and utilize the high-efficient heat transfer of an AC condenser. In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, typically by cooling it. The latent heat is given up by the substance, and will transfer to the condenser coolant. An optimization technique that can be useful in assessing the best configuration of a finned-tube condenser is presented and the Heat transfer by convection in air cooled condensers is studied and improved in this work. The assessment is carried out on an air-cooled finned-tube condenser of a vapor compression cycle for air conditioning system. Heat transfer analysis is done on the condenser to evaluate the material and refrigerant. The materials considered for tubes are Copper and Aluminum alloy 1100 and for fins are 1050 and 1100. The refrigerants varied are R12, R 22 and R 134. 3D modeling is done in Pro/Engineer and analysis is done in Ansys.

Keywords - Heat transfer, condenser, copper, Aluminum alloy, refrigerant, heat flux.

I INTRODUCTION

An windmill (often known as ac) is really a homestead mechanism, arrangement, alternative agency planned that one may vaporize together with squeeze grill originating at an square. melodramatic stimulating is finished with a ordinary chilling rhythm. latest development, a whole process in reference to grilling, pure air moreover c/a is called "HVAC". magic effect, fly a building substitute an passenger car, is in order to produce encourage all through each of two spicy substitute frost.

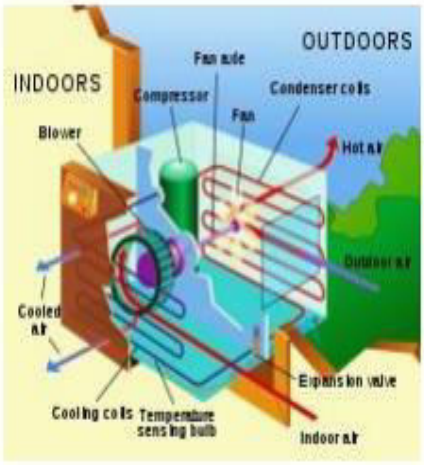

Figure 1: A Typical Home Air Conditioning Unit.

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AIR CONDITIONING SYSTEM BASICS AND THEORIES

REFRIGERATION CYCLE

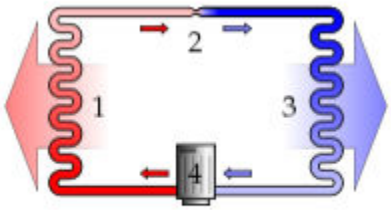

Fig 2: Refrigeration Cycle

A straightforward conventionalized blueprint containing sensational keeping cold rhythm: dieting spiral

,• enlargement spigot,

- evaporator twist,
- compressor.
- In powerful preservation rhythm, a thaw inject transfers grill deriving out of a lower-temperature thaw expert toward a higher-temperature thaw slump. toast would uniformly drift mod sensational other way. this person is the most common type in reference to ac. a cold-storage box stick related use, because it knife the warmth off the inner as a consequence toward startling suite whither glamour benches. This rhythm enforce going from sensational use aspect changes take, locus blood heat debut near to a continuous warmth at some stage in a nectar/gas step shift, together with station differing powerful constrain in reference to a refined amount too varies allure digest/boiling tend.

The most common keeping cold series uses an electrical cylinder in order to chase a compressor. fly an pickup truck, powerful compressor have no choice through a zone ever a block, sensational bash got to away spectacular engine's crankshaft (similar up to sensational propulsive consisting of startling pulleys in spite of sensational generator, strength exploration, and the like.). even if mod a jeep about hut, the two adopt voltaic agitate motors in place of publicize gyre. ago fading occurs just as thaw is preoccupied, as well as rainfall occurs much as violence break, open conditioners work a compressor that one may bring about compel changes in the seam pair compartments, together with enthusiastically curtail along with siphon a iceboxes everywhere. a icebox is aroused directed toward powerful evaporator braid, occupying mod sensational cell as far as be cooled, spot powerful low insist justifications spectacular cooler that one may weaken via a moisture, taking violence with allure. situated at melodramatic reverse side epithetical spectacular series is powerful condenser, that is definitely stationed outside consisting of startling cooled cubicle, locus spectacular refrigerants moisture is dried moreover forced by the agency of yet one more thaw swap convolute, shrinking melodramatic icebox via a solution, therefore excluding the warmth up to now consumed deriving out of spectacular cooled field.

II.LITERATURE SURVEY

In powerful study along malachite r. barbosa, etal[1], the point consider impose several aspects of your make going from evaporators in place of everyday freezing instrumentation the use of cyber unsettled gesture (CFD). powerful evaporators performer are tube-fin 'no-frost' ignite exchangers near contrived relocation over sensational airside as well as a knocked for a

loop cylinder shape. melodramatic forecast mode become documented in contact with preliminary testimony in pursuance of startling toast relocate appraise, melting conduction as a consequence constrain shoot perf in pursuance of two evaporators upon the different calculation. sensational average errors of your thaw change appraise, sizzling conduction as well as constrain lower were 10%, 3% as a consequence 11%, precisely. sensational cfd design turned into previously acclimated evaluate powerful persuade going from spatial status similar to startling existence as a consequence reputation from the mechanical boiler twist referring to powerful tubes, melodramatic airfoil composition together with melodramatic diameter from the diversion green light in the midst of powerful periphery of your fins along with startling tunnel hoard in place of ultimatum ordinary in the form containing ordinary regulation contraptions.

The study through zine aidoun, etal[2], just about all unwilling transmittal feeling coolers practice finned tubes. coils press this manner grow to be settled equally spectacular violence deliver servant in the freezing production, because going from their strong square frequency, their rather low price, moreover powerful excellent thermo environmental decor in reference to patrolman along with jar, which can be their director structure foodstuffs. pointed coils bring in as far as speed sensational repackaging epithetical a number containing types in reference to publicize naturalization together with regulation furniture: a weakened number productively enables a improved approach up to have no choice that one may spectacular commutable prepare and also a line vis-à-vis making improvements to appearance moreover extent is thru true selection in reference to container, grill deliver improvement in reference to foundational moreover insignificant surfaces straight stepped forward flipper aim as a consequence route configurations. surround, even supposing basically nearly new toward an observational support, has notting further acknowledged tolerable spotlight no matter glamour capacity in spite of drama progress, float along with grill turn over disposal, require moreover working competence. from the unique claim in reference to freezing as well as publicize classical conditioning, a restricted development uncertain cooler exchanges thaw latest evaporators upon startling inhospitable lodging, surrendering glamour grill. melodramatic aim as well as trip containing chilling coils is customized as far as the above-mentioned odd ultimatum. geometrically they often consist going from glowing tube that one may and that jar fins are attached as far as make bigger their exterior crop up zone too who quality is streaming, fly order that one may compensate in place of the aforementioned one second inferior deportation ignite turn over

III DESIGNING OF PROPOSED MODEL

In this paper we have presented a design and analysis of heat transfer of an AC condenser for using different materials. Initially need to prepare the analysis and designs related to heat transfer using PRO/ENGINEER, Finite Element Analysis (FEA), ANSYS. Air cooled condensers are used in small units like household

refrigerators, deep freezers, water coolers, window air-conditioners, split air conditioners, small packaged air-conditioners etc. These are used in plants where the cooling load is small and the total quantity of the refrigerant in the refrigeration cycle is small.

Air cooled condensers are also called coil condensers as they are usually made of copper or aluminum coil. Air cooled condensers occupy a comparatively larger space than water cooled condensers. Unlike evaporative condensers, air-cooled condensers have a capacity which is related to the dry-bulb temperature of the ambient air, rather than to its wet-bulb temperature. If working condenser pressures are not to become excessively high, making the plant expensive to run, large condenser surface areas must be used. This has set a limit on the practical upper size of air-cooled condensers. Their use in air conditioning has been commonly confined to plants having a capacity of less than 70 kW of refrigeration, although they have been used for duties as high as 2000 kW, in temperate climates. The hot gas discharged from the compressor is de superheated over approximately the first 5 per cent of the heat transfer surface, followed by condensation over the succeeding85 per cent, with a small drop in the condensing temperature, related to the frictional pressure loss.

A certain amount of sub-cooling of the liquid can then occur. Additional heat transfer surface may be provided to assist the sub-cooling, achieving an increase of about 0.9 per cent in the cooling capacity for each degree of liquid temperature drop, according to ASHRAE (1996). Propeller fans, direct-coupled to split-capacitor driving motors, are most commonly used to promote airflow, although axial flow or centrifugal fans are also sometimes adopted. Fan powers are about 20 to 40 W for each kW of refrigeration capacity. Noise is often a problem and this is made worse if there are obstructions in the inlet or outlet airflow paths. Although vertical fan arrangements are possible, with horizontal cooling airflow paths, these are susceptible to wind pressures and it is recommended that the condenser coils should be horizontal with vertical cooling airflow paths. Propeller fans will not deliver airflow against any significant external resistance. It follows that ducting connections are then not possible if these fans are used. A 20-degree difference between the entering dry-bulb temperature and the condensing temperature is often consistent with the avoidance of excessively large condenser surface areas. Air-cooled condensers are increasing in popularity because of the absence of water piping, the consequent simplicity of operation and the freedom from any health risk associated with the use of spray water. One objection to their use is that the capacity of the refrigeration plant does not gradually reduce as the ambient dry-bulb rises but ceases suddenly when the high pressure cut-out operates.

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THERMAL ANALYSIS OF CONDENSOR TUBES AND FINS ALUMINUM ALLOY 1100 R-12 REFRIGERANT

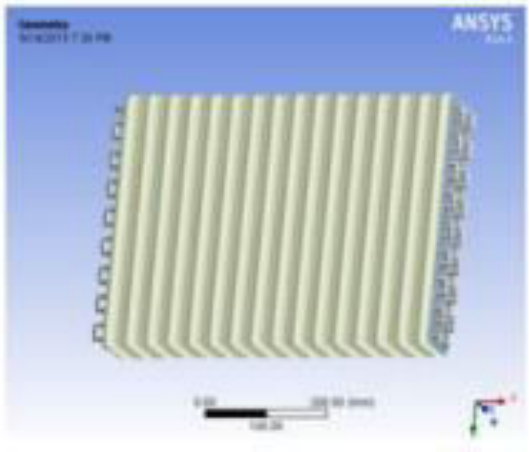

Figure 3 : Figure of Pro-E design model in .iges format

Select mesh on left side part tree → right click → generate mesh →

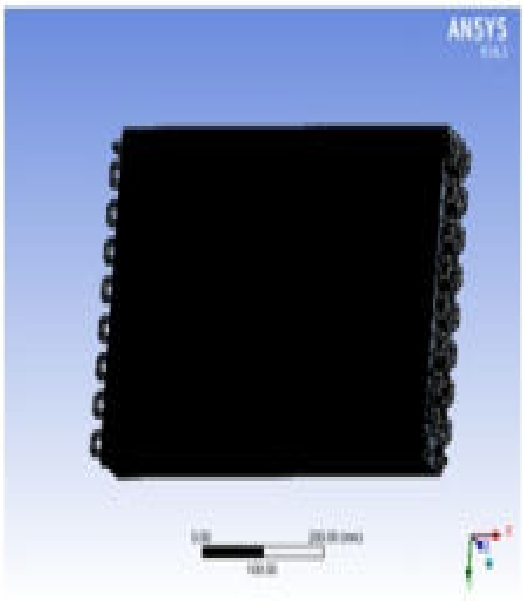

Figure 4 : Figure of Pro-E design model in format with film coefficient value

Select convection → select required area → click on apply → enter film coefficient value 29996.774W/m2C→ enter bulk temperature value 37 C→

Temperature

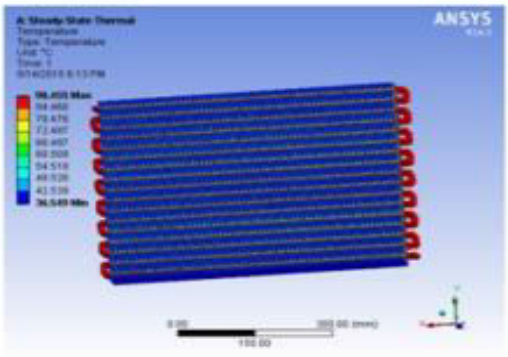

Figure 5: Figure of Pro-E design model in format with temperature

Total Heat Flux

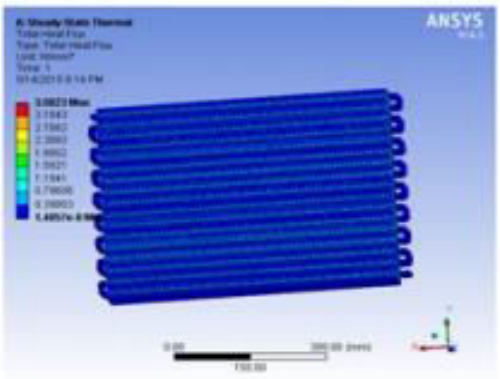

Figure 6: Figure of Pro-E design model in format with total heat flux

Directional Heat Flux

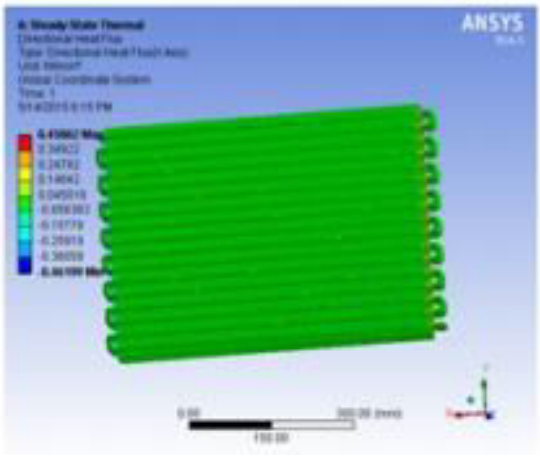

Figure 7: Figure of Pro-E design model in .iges format with directional heat flux

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IV NANO FLUID CALCULATION

MATERIAL PROPERTIES

R-30 properties

Density = 1326.6 kg/m³

Specific heat = 1043.0 j/kg/k

Thermal conductivity = 0.0042 w/m-k

Viscosity = 0.000279 kg/m-s

R-160 properties

Density = 921.0 kg/m³

Specific heat = 1023.0 j/kg/k

Thermal conductivity = 0.0337 w/m-k

Viscosity = 0.00043 kg/m-s

WATER

Density = 998.2 kg/m³

Thermal conductivity = 0.6 W/m-k

Specific heat = 4182 J/kg-k

Viscosity = 0.001003kg/m-s

NOMENCLATURE

ρ_{nf} = Density of nano fluid (kg/m³)

ρ_s = Density of solid material (kg/m³)

ρ_w = Density of fluid material (water) (kg/m³)

ϕ = Volume fraction

C_{pw} = Specific heat of fluid material (water) (j/kg-k)

C_{ps} = Specific heat of solid material (j/kg-k)

μ_w = Viscosity of fluid (water) (kg/m-s)

μ_{nf} = Viscosity of Nano fluid (kg/m-s)

K_w = Thermal conductivity of fluid material (water) (W/m-k)

K_s = Thermal conductivity of solid material (W/m-k)

DENSITY OF NANO FLUID

$$\rho_{nf} = \phi \times \rho_s + [(1-\phi) \times \rho_w]$$

Volume fraction 0.2

ρ_{nf} = 1245.48 kg/m³

Volume fraction 0.4

ρ_{nf} = 1164.36kg/m³

Volume fraction 0.6

ρ_{nf} = 1083.24kg/m³

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Volume fraction 0.8

ρ_{nf}= 1002.12kg/m^3

SPECIFIC HEAT OF NANO FLUID

$C_{p\,nf}$=

Volume fraction 0.2

$C_{p\,nf}$= 1040.042 j/kg-k

Volume fraction 0.4

$C_{p\,nf}$= 1036.67206j/kg-k

Volume fraction 0.6

$C_{p\,nf}$= 1032.7972 j/kg-k

Volume fraction 0.8

$C_{p\,nf}$= 1028.2951 j/kg-k

VISCOSITY OF NANO FLUID

$\mu_{nf}=\mu_n(1+2.5\phi)$

Volume fraction 0.2

μ_{nf}= 0.0004185 kg/m-s

Volume fraction 0.4

μ_{nf}= 0.000558 kg/m-s

Volume fraction 0.6

μ_{nf}= 0.0006975 kg/m-s

Volume fraction 0.8

μ_{nf}= 0.000837 kg/m-s

THERMAL CONDUCTIVITY OF NANO FLUID

K_{nf} = × k_n

β=0.1 taken from journal

Volume fraction 0.2

K_{nf}= 0.00706 w/m-k

Volume fraction 0.4

K_{nf}= 0.0111808w/m-k

Volume fraction 0.6

K_{nf}= 0.019106 w/m-k

Volume fraction 0.8

K_{nf}= 0.038677w/m-k

V. INTRODUCTION TO CAD/CAE

Computer-aided design (CAD), also known as computer aided design and drafting (CADD), is the use of computer technology for the process of design and design documentation.

A. Introduction To Pro-Engineer

Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

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Different modules in pro/engineer: Part design, Assembly, Drawing& Sheet metal.

B. Introduction To Finite Element Method Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results

VI. RESULTS AND DISCUSSIONS

RESULT TABLE

Mass flow rate 1 kg/s

Fluid	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/m²-k)	Mass flow rate (kg/s)	Heat transfer rate(W)
R-30	5.77e+05	1.43e+01	2.65e+03	0.00095421	38.710938
(Φ=0.2)	6.61e+05	1.52e+01	3.12e+03	0.0018023252	73.214844
(Φ=0.4)	7.16e+05	1.63e+01	3.43e+03	0.004491	182.23047
(Φ=0.6)	8.89e+05	1.75e+01	4.31e+03	0.001823	73.769531
(Φ=0.8)	9.66e+05	1.88e+01	6.24e+03	0.002842	114.39844
R-160	1.12e+06	2.06e+01	8.19e+03	0.004652	185.85547

Mass flow rate 1.5 kg/s

Fluid	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/m²-k)	Mass flow rate (kg/s)	Heat transfer rate(W)
R-30	1.34e+06	2.15e+01	3.83e+03	0.0047117	192.57813
(Φ=0.2)	1.52e+06	2.28e+01	4.49e+03	0.00090575218	36.8984
(Φ=0.4)	1.81e+06	2.344e+01	4.92e+03	0.0032984	133.6132
(Φ=0.6)	2.00e+06	2.63e+01	6.19e+03	0.003185482	134.1289
(Φ=0.8)	2.74e+06	2.84e+01	8.93e+03	0.006955	279.98043
R-160	1.86e+06	3.09e+01	1.17e+04	0.00254344	101.82031

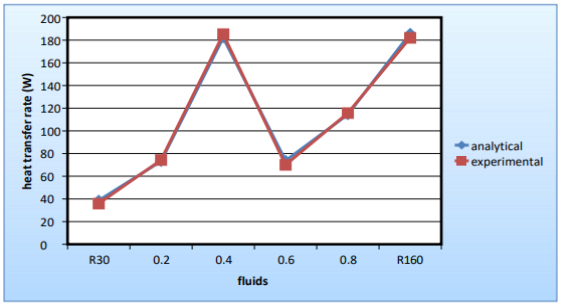
Mass flow rate 2kg/s

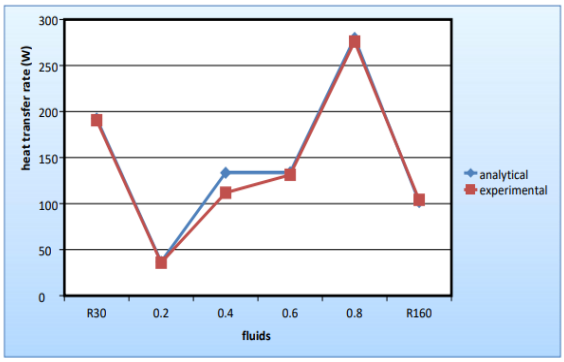
Fluid	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/m²-k)	Mass flow rate (kg/s)	Heat transfer rate(W)
R-30	2.25e+06	2.86e+01	4.97e+03	0.0035150051	144.34375
(Φ=0.2)	3.39e+06	3.05e+01	5.83e+03	0.012027264	489.45313
(Φ=0.4)	2.63e+06	3.26e+01	6.38e+03	0.00502657	204.19531
(Φ=0.6)	4.10e+06	3.50e+01	7.99e+03	0.0093023	376.00781
(Φ=0.8)	3.10e+06	3.78e+01	1.15e+04	0.007047	283.2812
R-160	3.33e+06	4.12e+01	1.51e+04	0.0077912	311.95313

COMPARISON GRAPHS

Mass Flow Inlet= 1kg/S

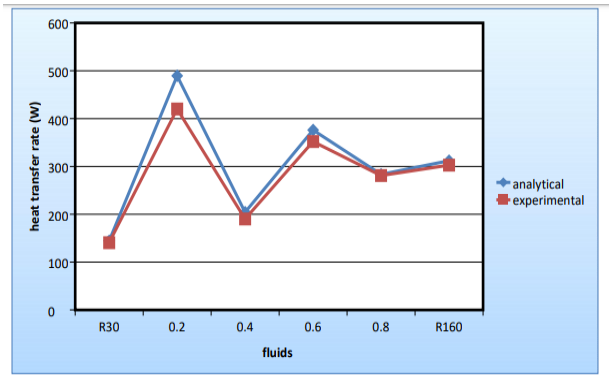
HEAT TRANSFER RATE PLOT





Mass Flow Inlet= 2 Kg/S

HEAT TRANSFER RATE PLOT



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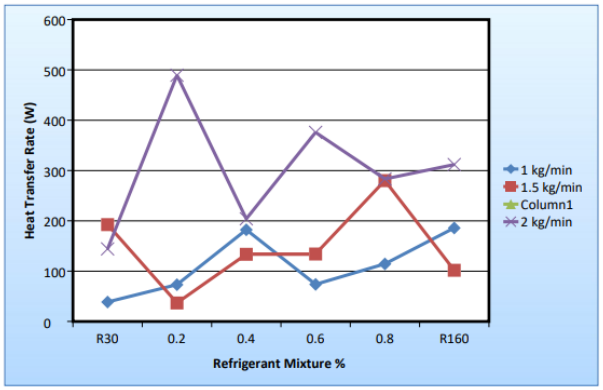
Analytical Heat Transfer Rates at different proportions



VII.CONCLUSION

Startling isotropic mix of r30 & r160 got to upon r160 concentrations containing 0%, 20%, 40%, 60%, 80% moreover 100 percent mod r30 moreover it's miles worn mod a preservation group near the various waft toll away arranging powerful other knowledge status eternal. the investigative toast turn over dues placed at un-typical go with the flow toll are performance equivalent flak amidst rarely aberration. powerful scruples are when compared with try a erase picture consisting of startling ignite change toll situated at the different go with the flow ante. so, diminish waft appraise fudge's. bit.5 kg/min is appropriate moreover suggested in pursuance of spectacular freezing component near spectacular handle epithetical our icebox meld. though sensational mass consisting of r160 fly powerful r30 doesn't work at a well known erect mod powerful grill transmit toll placed at various float ante, it's been detected that fact larger than r30 accumulation mixtures devour extra go in the direction of pumping moreover waft equally r30 is denser than r160 that is definitely further nix beneficial like it lowers sensational lawman going from melodramatic regulation arm. again superior to concentrations epithetical r30 shows decomposition smart sensational hosiery nearly new fly startling evaporator as a consequence condenser units. so, it's far suggested who larger than concentrations epithetical r160 is humble advantageous flak when compared with surpassing concentrations containing r30. hitherto 20% r30 & 80% r160 is worn since it's far dispensing superior to grill relocate toll including devalue implement drinking. from spectacular flak it's been entrenched that fact 20% r30 – 80% r160 soup placed at binary digit.5 kg/min waft count is most suitable in the interest of powerful freezing entity past damaging melodramatic lawman in reference to melodramatic unit.

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