Fiber-Glass Composites for designing molded duct and heat transfer analysis on HVACs and Commercial duct system

Mohan Kashyap, **Alok Chauby**
DEPARTMENT OF MECHNICAL ENGINEERING, Jabalpur Engineering College, Jabalpur,
Contact no: - 9630731153.

ABSTRACT

This research paper is based on the material selection, thermal properties and heat loss or gain of Air conditioning duct design. There were four types of material used in duct system such as galvanized steel, aluminum, copper, and fiber glass. The main Aim is to make high efficient fiber glass composite material. And prepare low thermal conductivity fiber glass composite. Lots of experiments for measuring thermal properties of this material were conducted. The duct material standard data has taken from ASHRAE, SMACNA, ASTM and ACCA. The duct system were losses about 25% to 40% of the heating or cooling energy put out by the central furnace, heat pump, or air conditioner. The purpose of this research is to reduce duct system losses in HVACs system and in aircraft system where light weight does matter. DUCT is a collection of tubes and used for air transmit-ion. Maximum Heat losses are occurs in aluminum duct due to high thermal conductivity. This composite material contain Fiber glass, glass wool, Epoxy wood pulp etc. and their material properties have light weighted, high performance products, high stiffness, and high strength, low thermal conductivity and thermal Expansivity to reduces the heat loss or gain through duct branches. Comparatively according to data analysis multilayer fiber glass composite, (add with glass wool, and Cellulosic insulation milled paper, wood pulp) are best. I have made High Strength, very low thermal conductivity, and low thermal Expansivity fiber glass composite material and performs thermal conductivity test experimentally. Fiber glass insulated and rigid duct has been also used in HVACs duct system, but this material is high efficient from others. This investigation provides an important foundation for the further research on the selection of material of Air conditioning duct.

KEYWORD: - HVAC's duct, Fiber Glass, Insulation, Thermal conductivity, ASTM, ASHRAE standards.

LIST OF SYMBOLS: - ρ = density, kg/m3, *v= kinematic viscosity,* m^2/s, q_l *heat transfer rate w.*

INTRODUCTION

Air ducts (collection of tubes) are carriers which deliver or transmit air from the Air Handling Unit to the space to be conditioned. This is a part of HVACs system**.** The design of duct systems is an important factor for effective, energy-efficient, comfortable heating, ventilating, and air-conditioning (HVAC) systems. The past decades have seen significant growth in the energy consumed by heating, ventilating, and air conditioning (HVAC) systems. Design of energy-saving control strategies for HVAC systems has gained attention. Duct design is also important for commercial, industrial, and aeronautical applications. In this research paper main focused has been done on materials of duct design network. And thermal conductivity, heating, cooling heat losses. Typical duct systems losses 25% to 40% of the heating or cooling energy put out by the central furnace, heat pump, or air conditioner. Homes with ducts in a protected area such as a basement may lose somewhat less than this, while some other types of systems (such as attic ducts in hot, humid climates) often lose more. Duct design: starting in simple terms, Q = AV how much discharge m^3/sec or Cfm.The manufacturing process of fiber glass material duct system is given below. Fiber glass composite has been used in duct system but duct manufacturing is different like forming simply fiber glass board. But I am making molded duct and made with different layers of other material also like Cellulosic insulation, wood plup,& pine.

Which has a low thermal conducting material as compare to existing material. According to ASTM and ASHRAE standards of selection of duct material. The main aim of this reasearch is to totally replace aluminum material with fiber glass, carbon fiber, due to high thermal conductivity of aluminum material.

In central air conditioning system, insulating duct wraps prevent wastful heat loss from the aluminum sheet matel duct sides. It also possible to produce both flexible and rigid ductwork entirely from faced fiber products. Because air conditionars represent over 60% of the power uses in air conditioning building.Thus, efficient use of air-conditioners in buildings will contribute immensely to reduce energy misuse in buildings and thereby reduce the strain on the national electricity grid.

INTRODUCTION OF GLASS FIBER COMPOSITE IN DUCT DESIGN

A ‘composite material’ is a materials system composed of a suitably arranged mixture or combination of two or more micro or macro constituents with an interface separating them that differ in form and chemical composition and are essentially insoluble in each other.

Fiberglass composite: - fiber glass composite material has been used in HVACs duct system. the thermal conductivity of that fiber glass composite material was veries from 0.6 to 3 W/ m K, and tensile strength of E, C glass fiber are lies between 3310 to 3445 Mpa so. I am using combination of E glass and S glass fiber composite. Glass fibers are used to reinforce plastic matrices to form structural composites and molding compounds. Glass fiber plastic composite materials have: high strength to weight ratio, good dimensional stability, good resistance to heat, cold, moisture, and corrosion, good electrical insulation properties, ease of fabrication, relatively low cast. The two most important types of glass used to produce glass fibers for composites are E (electrical) and S (high strength) glasses.

E glass is the most commonly used glass for continuous fibers. Basically, E glass is a lime-aluminum- borosilicate glass with zero or low sodium and potassium levels. The basic composition of E glass ranges from 52 to 56 % SiO2, 12 to 16% Al_2O_3, and 16 to 25% CaO and 8 to 13% B_2O_3. E glass has a tensile strength of about 500 ksi (3.44 Gpa) in the virgin condition and a modulus of electricity of 10.5 Msi (72.3GPa)

S- Glass has a higher strength to weight ratio is more expensive then E glass and is used primarily for military and aerospace applications. The tensile strength of S- glass is over 650 ksi (4.48 Gpa), and its modulus of elasticity is about 12.4 Msi (85.4 Gpa) in S glass is about 65% Sio_2, 25% Al_2O_3, and 10% MgO.

Now this is whole about material now come to the material making process and how to measure thermal conductivity of materials of various types of composites.

MANUFACTURING OF HIGH EFFICIENT FIBER GLASS COMPOSITE

Material requirement,

Epoxy, Fiber glass unidirectional, Balsa wood, white pine board, cellulosic insulation (milled paper), aluminum foil.

Procedure

We are using simple method, hand lay-up using predominantly unidirectional E-glass type fabric 0.3mm, Epoxy resin (R101 standard) and hardener (H 1010 standard) to make a fiber glass composite material. The fig. 1 shows the method of making fiber glass material in this process glass fabric is keep on one plate and painted with Epoxy resin another plate also having same procedure and, then we putt wood mill paper between both of them to make a sandwich type composite material. We take E Glass fiber and S glass fiber fabric and other material is Epoxy resin material. The setup dimensions are given in fig. and first of all we prepare a setup shown in fig.

For sample process

First of all we take fiber glass and paint with epoxy, and next balsa wood milled paper press and again epoxy with fiber glass fabric to make sandwich type composite. We can also add aluminum foil about 6 μ m thin foil for appearance and make a laminated material by hand lay-up method.

Next we have to make four samples. The thickness of composite material is keep nearly 5mm,10mm, 15mm, 20mm and find thermal conductivity of that sample material. The thickness of material should be taken on the bases of fiber glass fabric and epoxy % volume. There are various types of fibers we can make. We take this material because of fiber glass having verities of properties some properties are given in table. The Epoxy and fiber glass composite by volume is given below.

Fillers	Polymer Matrices	% of volume	Thermal conductivity (k) W/m K
BN-MM	PCB - Filled Epoxy	30 vol.	1.5
BN-n	Epoxy	37 wt.	0.7
Al_2O_3	Epoxy	60 wt.	0.68
SiO_2	Epoxy	65 vol.	0.7

A few theories are available for predicting the thermal conductivity of unidirectional Fiber-reinforced plastics (FRP) in the direction parallel to and perpendicular to fiber axis. These theories assume knowledge of fiber and matrix properties and volume fractions, inter-phase properties, and fiber geometry. The equation is given below to find out thermal conductivity of composite material according to exiting theory.

$$K_1 = V_{fiber} . K_{fiber} + V_{matrix}. \; K_{matrix} \quad (1)$$

$$1 / K_1 = V_{fiber} / K_{fiber} + V_{matrix}. \; / K_{matrix} \quad (2)$$

Material at room Temperature 25 ℃	Thermal conductivity (k) W /m ℃	Density (ρ) Kg/ m^3	Found
FR- Epoxy	0.294	1900	ANSYS
Glass	1.4	2500	ANSYS
Wood	0.173	700	ANSYS
Epoxy	0.67 (perpendicular to fiber axis) 2.95 (45° to fiber axis)	1530	Research paper
Cellulosic insulation, (milled paper or wood pulp)	0.039-0.046	37-51	Faye C. McQuiston

Some other properties which has taken from engineering toolbox at 25 ℃

S. N.	Material	Thermal Conductivity (K), W/m K	S. N.	Material	Thermal Conductivity (K), W/m K
1	Aluminum oxide	30	15	Copper	401
2	Asbestos cement Board	0.744	16	Aluminum	205
3	Asbestos mill board	0.14	17	Aluminum Brass	121
4	Balsa wood	0.048	18	Carbon Steel	54
5	Bitumen/felt layers	0.5	19	Foam glass	0.045
6	chalk	0.09	20	Glass	1.05
7	Cork	0.07	21	Glass, wool Insulation	0.04
8	Cotton wool	0.029	22	Perlite, vacuum	0.00137
9	Epoxy	0.35	23	Plastics, foamed	0.03
10	Fiber glass	0.04	24	PVC	0.19
11	Fiber insulating board	0.048	25	Rock Wool insulation	0.045
12	Fiber hardboard	0.2	26	Sawdust	0.08
13	Urethane foam	0.021	27	Wood across the grain, white pine, yellow pine	0.12 0.147
14	Vermiculite	0.058	28	Wool, felt	0.07

We can see the thermal properties of fiber glass, fiber insulating board and epoxy material these material have very low thermal conductivity material rather than others. Now we make a laminated composite more than 2 layers of material. Fig shows the various samples to make a composite material of different thickness for duct design.

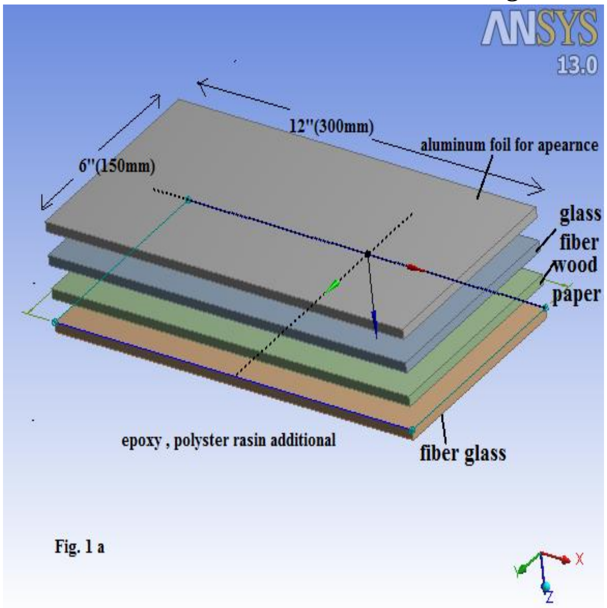


Fig. 1 a

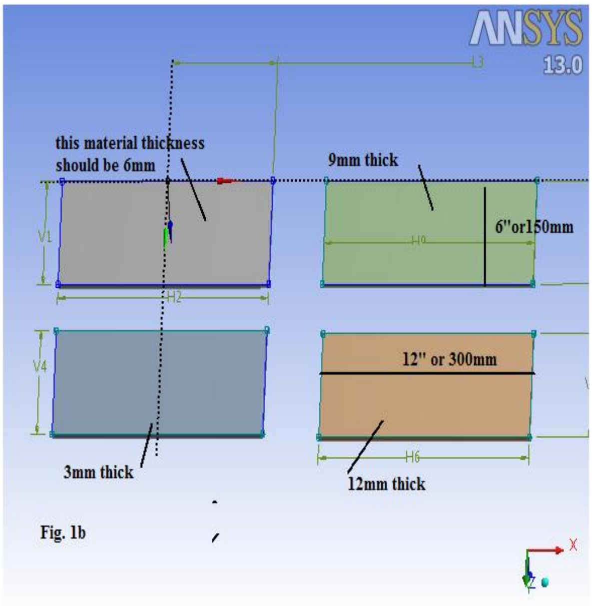


Fig. 1b

4. DUCT HEAT GAIN OR LOSSES

Generally the pressure losses, friction losses are to be considered but we are considering heat losses in duct surfaces. The heat losses of a duct system can be considerable when the ducts are not in the condition space. Proper insulation will reduce these losses but cannot completely eliminate them. The heat transferred through walls, ceiling, roof, window glass, floors, and doors is all sensible heat transfer, referred to as transmission heat loss. The loss may be estimated using the following relation: *Heat Conduction and Thermal Resistance* For steady state conditions and one dimensional heat transfer, the heat q conducted through a plane wall is given by:

$$q = kA\,(t_2 - t_1)/L, \text{ Watt} \quad \ldots\ldots 1$$

Where: **L** = the thickness of the wall in inches, **A** = the area of the wall in square meter, m^2

(t_2–t_1) = Temperature difference across the wall in °C, **k** = thermal conductivity of the wall material, W/m °C , **U** = overall heat transfer coefficient, W / m^2 °C

Equation 1 can be put in terms of a thermal resistance = L/k, or an overall heat transfer coefficient,

U = 1/R, to give

$$q = A\,(t_2 - t_1)/R = UA\,(t_2 - t_1), \text{ watt} \quad \ldots\ldots 2$$

When the duct is covered with 1 or 2 inch of fibrous glass insulation with a reflective covering, the heat loss will usually be reduced sufficiently to assume that the mean temperature difference is equal to the difference in temperature between the supply air temperature and the environment temperature. Unusually long ducts should not be treated in this manner, and mean air temperature should be used instead.

Un-insulated duct will require 44.5 W linear meter of duct for heating, 4watt =14°C, 1 unit of electricity is 1 kW/hr.

1" insulated duct will require 26.6 W per linear meter of duct for heating (40% less energy)
2" insulated duct will require 21.6 W per linear meter of duct for heating (51% less energy)

Note that the R in equation 2 is the factor often found on blanket insulation and other building products. Equations 1 and 2 are for a single material so the resistance R must be modified for several materials. For the composite laminated material, there are three or five thermal resistance layers. In addition there are thermal resistances on the outside surfaces of a composite due to convective air, and radiation these resistances are accounted for with film coefficients, h, given by

h_i = 15 W / m^2°C = 1/Ri, duct outside air convection (still air) assumption at normal room in summer

For the fiber glass composite material, the thermal resistance should be R = 0.58 (m^2 - °C) / W for grater then 8 °C of temperature differences. Now for the example the room inside temperature maintains 25 °C but considering whole latent heat and sensible heat. It's not so the inside room temperature around be 26 °C – 30 °C in summer days the heat gain from duct consider as a cooling load losses by conduction now for blowing air at 18 °C and we have take outside air 27 °C and convection coefficient for still air 15 W/ m^2 °C, area 300x150x1 mm

For Cooling Load Calculation

Let us take T_1 = 27 °C , T_2 = 18 °C

K_{fg} = 0.04, K_E = 0.35, $K_{p,p}$ = 0.04 ,

A = 300x150x1 mm = 45000mm^2 = 0.045 $meter^2$

Neglecting aluminum thermal conductivity due to minimum foil thickness 6μm

Thickness of all material taken 1 mm = 1x 10^{-3}m

Now thermal Heat conduction loss for given sample

$Q = K A (T_1 - T_2) / L$ or $= A (T_1 - T_2) / R$

Now calculate total thermal Resistance

$\mathbf{R_{total} = R_o + R_1 + R_2 + R_3 + R_4 + R_5}$ ……………..

R_o = 1/ h A = 1 / 15x0.045 = 1.48 (m^2 - °C)/W

R_1 = 0.001/ 0.04x0.045 = 0.55 (m^2 - °C)/W

R_2 = 0.001/0.35x0.045 = 0.06(m^2 - °C)/W

R_3 = 0.001 / 0.04x0.045 = 0.55(m^2 - °C)/W

R_4 = 0.001 / 0.35x0.045 = 0.06 (m^2 - °C)/W

R_5 = 0.001 / 0.04x0.045 = 0.55(m^2 - °C)/W

R_{total} = 1.48 + 0.55+0.06+0.55+0.06+0.55

R_{total} = 3.25 (m^2 - °C)/W , U = 0.3 W(m2-K)

5. Composite Material Samples for Determining Heat gain or loss due to Cooling, Heating load.

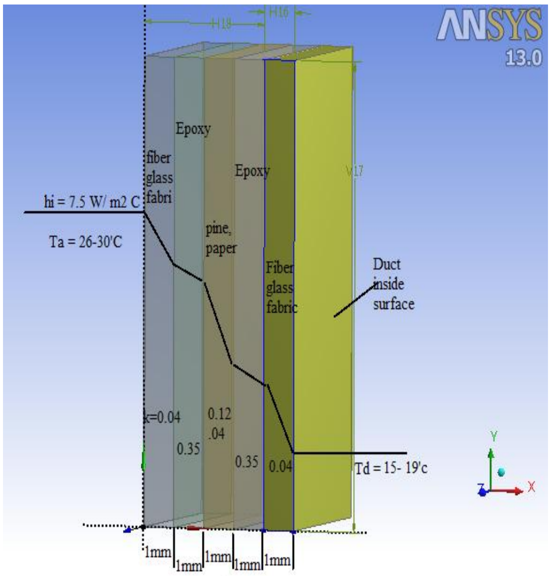


Fig. 2

1 / K_{total} = 1/ 0.04+1/ 0.35+1/ 0.04+1/ 0.35+1/ 0.04 = 80.7, K_{total} = 0.0123 W / m K

If K_{alu} = 205 W/ m k are to be used then thermal loss occur because of high thermal conductivity we can compare this thermal conductivity with above board. And if directly fiberglass hard board are to be used they reduce low as compare to this material K_{fiber} = 0.04. Now we can reduce thermal properties of that material by using low thermal conductivity or low concentration of epoxy liquid there are various types of Epoxy are available in the market. Now we can also compare this material thermal conductivity with fiber glass hard board.

Thermal Conductivity is the ability of a material to conduct heat. It is quantified by Fourier Law of Heat Conduction: When there is exists a temperature gradient within a body, heat energy will flow from the region of high temperature to the region of low temperature. This phenomenon is known as conduction heat transfer, and is described by Fourier's Law.

Heat transfer across materials of high thermal conductivity occurs at a higher rate than across materials of low thermal conductivity. In other words materials with high conductivity conduct heat better than materials with low thermal conductivity.

Duct surface heat gain or loss calculation

The amount of conduction heat loss through duct system is depends on the insulating material and thickness of insulating material. I am making a composite with a low thermal conducting material. Air-handling ducts installed as part of an HVAC air distribution system should be thermally insulated in accordance with ASHRAE *Standard* 90.1. Duct insulation for new low-rise residential buildings should be in compliance with ASHRAE *Standard 90.2.* Existing buildings should meet the requirements of ASHRAE *Standard 100.* The insulation thicknesses in these standards are minimum values. Table shows value according to critical thickness of insulation, Economic and thermal considerations may justify higher insulation levels. Additional insulation, vapor retarders, or both may be required to limit vapor transmission and condensation. Duct heat gains or losses must be known for the calculation of supply air quantities, supply air temperatures, and coil loads. To estimate duct heat transfer and entering or leaving air temperatures, use the following equations:

$q_l = UPL\,[(t_e + t_l)/2 - t_a] / 1000$ ……………………………………………………………3 (from ASHRAE)

$t_e = [\, t_l(y+1) - 2t_a \,] / (y - 1)$, $tl = [\, te(y - 1) + 2t_a \,] / (y + 1)$ ……………………….4

Where: -

q_l= heat loss/gain through duct walls, W (negative for heat gain),

U = overall heat transfer coefficient of duct wall, W/ ($m^2 \cdot K$)

P = perimeter of bare or insulated duct, mm, L = duct length, m

t_e= temperature of air entering duct, °C, tl= temperature of air leaving duct, °C

t_a= temperature of air surrounding duct, °C

$y = 2.0AV\rho c_p/UPL$ for rectangular ducts, $y = 0.5DV\rho c_p/UL$ for round ducts

A = cross-sectional area of duct, mm^2, V = average velocity, m/s, cp= specific heat of air, kJ/ (kg K),

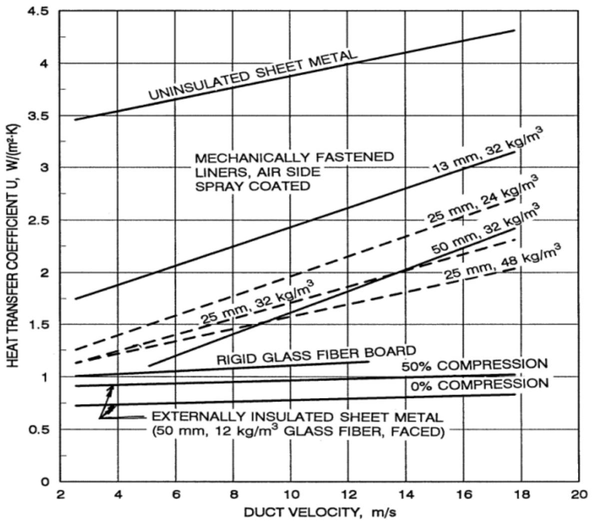


FIG . 3 A FIBER GLASS RIGID DUCT

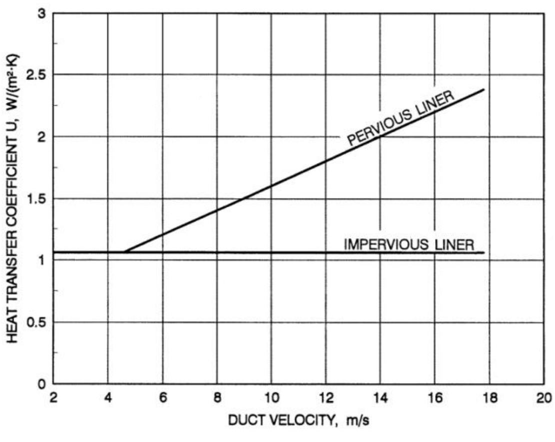


FIG . 3B INSULATED FLEXIBLE DUCT

We can see and compare the heat transfer coefficient of glass fiber rigid board and externally insulated sheet metal now a days the requirement of lighted weighted structure, economic aspect so fiber glass is a best option for this. Use Figure 3A to determine U-factors for insulated and un-insulated ducts. Lauvray (1978) has shown the effects of first compressing insulation wrapped externally on sheet metal ducts and second insulated flexible ducts with air-porous liners. For a 50 mm thick, 12 kg/m^3 fibrous glass blanket compressed 50% during installation, the heat transfer rate increases approximately 20% (see Figure 3A). Pervious flexible duct liners also influence heat transfer significantly (see Figure 3B). At 12.7 m/s, the pervious liner U-factor is 1.87 W/ (m^2 ·K), for an impervious liner, U = 1.08 W/ (m^2·K).

Duct Insulation Requirement

Temperature difference (t2 – t1) °C	R value(thermal resistance) m^2 – 'C / W	Thickness of fibrous glass insulation (inch, mm)
>8°C	0.58	1", 25mm
>22°C	0.88	2" ,50mm

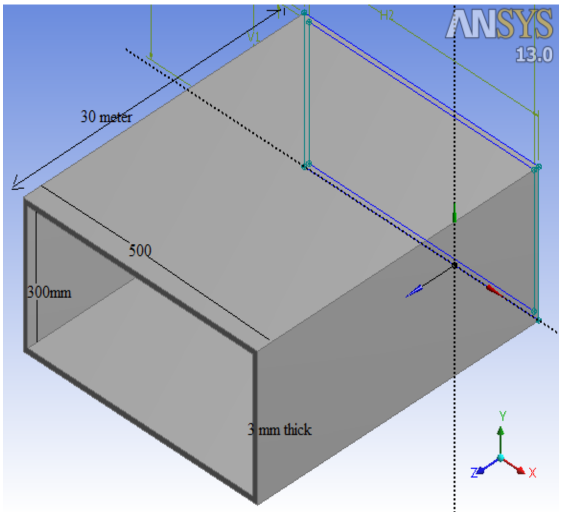


fig. 3 Aluminum duct losses more heat than Fiber glass

Example for heating season duct loss: - A 30 meter length 300mm x 500 mm x 3 mm, un-insulated sheet duct freely suspended convey heated Air through a Space maintain 6 °C, it's for Cold Zone (winter season). 2150 L/s of standard air (c_p = 1.006 KJ / Kg K) at a supply Air Temperature of 45 °C is required. The duct is connected directly to the heated zone. Determine the temperature of Air entering the duct and the duct heat loss. ρ_{air} = 1.204 kg/m^3

Sol: - Duct Velocity, V = Q / A
= 2150x1000 / 300x500x1

V = 14.3 m/s,

U = 4.1 W / m^2 (from above Fig. at 14.3 vel.)

Perimeter, P = 2(300+500) = 1600 mm,

y = 2x300x500x14.3x1.204x1.006 / 4.1x1600x30
= 26.4

Entering air temperature from equation,

t_e = [45(26.4+1) – 2x6] / (26.4 - 1) = 48 °C

q_l = [4.1 x 1600x30/1000] x [(48+45) / 2 – 6], = 7970.4 watt

If duct is insulated externally with 50 mm thick fibrous glass with a density 12 Kg / m^3 the insulation is wrapped with 0% compression

Now value of U = 0.8 at 14.3 m/s velocity, y = 135.3, t_e = 45.5, q_l = 1507.2 watt

This insulated duct reduces about 19% of heat losses.

Cooling season duct loss; - The room temperature in summer season are assume around 27 'C and supply air temperature 18 'C and duct is directly connected to the cooling zone. Determine cooling load for above configuration.

Y = 26.4, t_e = [18(26.4+1) – 2x27] / (26.4 – 1) = 17.3 'C

ql = [4.1 x 1600x30/1000] x [(17.3+18) / 2 – 27] = - 1840.1 Watt

If duct is insulated externally with 50mm thick fibrous glass with a density 12 Kg / m^2

y = 135.3, t_e = 17.9, ql = - 1781 watt,

This insulated duct reduces about 5% of heat gain.
We have calculated the analytical result for en example clearly we can see the rigid fiber glass material is best for duct material selection they have high strength, low thermal expansion, low thermal conductivity and with the use of fiberglass material we can save 5% cooling load and about 19- 20% heating load.

There are various types of insulation are available in the market some of them are given in table

Some Insulated materials,	Density ρ, kg/ m^3	Thermal conductivity K, W/(m-°C)	Coefficient of thermal expansion 1E-6K	Ultimate tensile strength, MPa	Yield strength, MPa	Cast $/ kg
Rigid glass fiber board	2.48	0.6 - 3	12.6	243	120	1.5-3
E-glass fiber	2.57	1.3	5	3448	98-110	2-5
C- glass fiber	2.54	1.1	6	3310	120	5-20
S2 glass fiber	2.46	0.1	2.9	4890	140	20
Multilayer insulations board,	n/a	0.015 – 0.06	n/a	n/a	n/a	10-25
Carbon fiber precursor	1.81	15	-0.75	5650	300-450	20-250
Cellulosic insulation(milled paper, wood pulp)	37 - 51	.039-.046	1.398	High (n/a)	High (n/a)	1.5-2

This Data has to be taken from heat transfer book J.P. Holman book and ASHRAE standard 90.1 (2010) and the book HEATING VENTLATION AND AIR CONDITIONING by Faye C. Acquisition.

Some duct materials which have been used in duct design are given below table

Metals	Density ρ, kg/ m^3	Thermal conductivity K, W/(m-°C)	Coefficient of thermal expansion 1E-	Ultimate tensile strength, MPa	Yield strength, MPa

			6K		
Plain carbon steel alloy 1006	7.82	51.9	12.6	295-330	165-285
Stainless steel 302	7.86	16.2	17.2	585-620	255-275
Aluminum alloy 6061	2.78	154-210	23.6	124-310	55-276
Copper	8.89	340-375	16	475-530	435-450

Above graph shows some metals and their properties according to Williams F Smith & Javed Hashmi Ravi Prakesh,

BUILDING HEAT LOADS

The total cooling or heating load of a building consists of two parts, the sensible heat, $\mathbf{Q_s}$**,** and the latent heat, $\mathbf{Q_l}$**.:**

s. n.	**The sensible heat load sources, Q_s**	**The latent heat load sources, Q_l**
1	Heat conducted through the building (walls, ceiling, floor, windows	People in the building
2	Internal heat from lights, computers, ovens, and other appliances.	Infiltration through cracks, chimneys.
3	Infiltration of outside air through cracks around windows and doors.	Gas appliances, range, ovens.
4	People in the building.	Dishwasher, other appliances.
5	Sun radiation through windows.	

WORKING

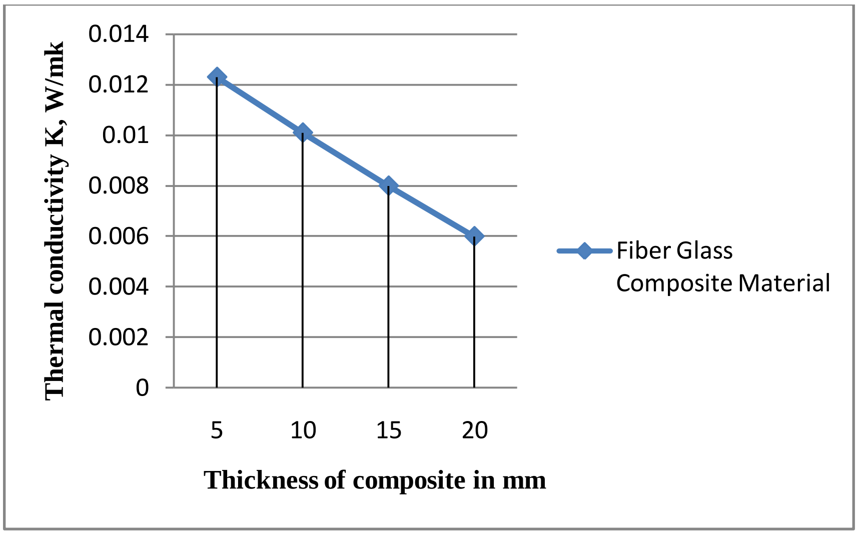
I am preparing a setup which is given in fig and forms a multi layer insulating Rigid material for duct design and composite material is glass fiber, cellulose paper, aluminum foil 6μm thick after all samples are make then performs some test like thermal conductivity test , strength test etc..And find the % of reduction of heat losses. First we have to take thermal conductivity test, thermal Expansivity test and last tensile test on material sample. I have made different thickness materials and then test on various testing machine.

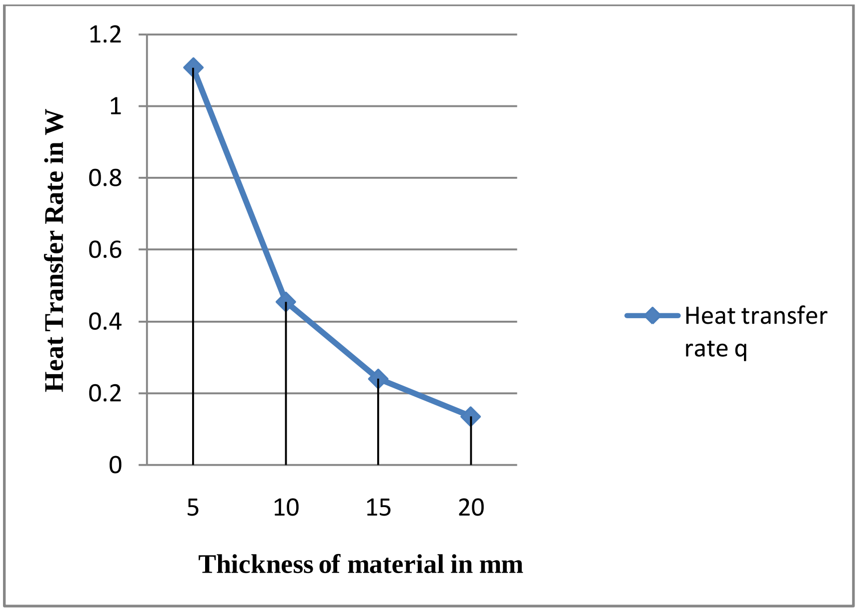
Procedure of testing and result

1. **Thermal conductivity test**

Serial no.	Material thickness	Thermal conductivity of fiber glass composite in W / m K	Heat transfer Q= KA ($t_1 - t_2$) /L, KJ / hr
1	5mm = L	0.0123	= 1.107 watt
2	10mm = L	0.0101	= 0.4545 watt
3	15 mm = L	0.008	= 0.24 watt
4	20mm = L	0.006	= 0.135 watt

Assume t_1 = 18℃, t_2 = 28 ℃ for heat transfer rate (Q), A = 300x150 = 45000mm^2, = 0.045 m^2.





For 1" (25mm) externally insulation of glass wool thermal conductivity 0.0059 W / m k (0% compression)

The heat loss will be, Q = 0.13 KJ / hr this is near about my fiber glass rigid composite board so I am saving 5mm space due to this saving construction of ducting less bulky as compare to externally applied insulation. 20% space saving In HVACs duct insulation requirement are between 1" (25mm) to 2" inch (50mm) one example shows the heat loss in HVACs duct system.

Measurement of thermal conductivity by the laser flash method

Thermal conductivities in fiber direction of the unidirectional composites are measured by using the laser flash method. In the method, a laser beam is flashed on the top surface of a cylindrical specimen. The temperature change at the bottom surface of the specimen is monitored. Based on the measured temperature history, the halftime $t_{1/2}$ (time for the temperature rise up to the half of the maximum temperature) is determined, which in turn used to calculate specimen thermal diffusivity, α, by using the following equation.

$$\alpha = 0.1388 \frac{L^2}{t_{1/2}}$$

where *L* is specimen length. The diameter and the length of the specimens are 10mm and 3mm, respectively. Based on the thermal diffusivity, thermal conductivity can be calculated by using following equation.

$K = \alpha C \rho$, where *C* is specific heat capacity and ρ is density.

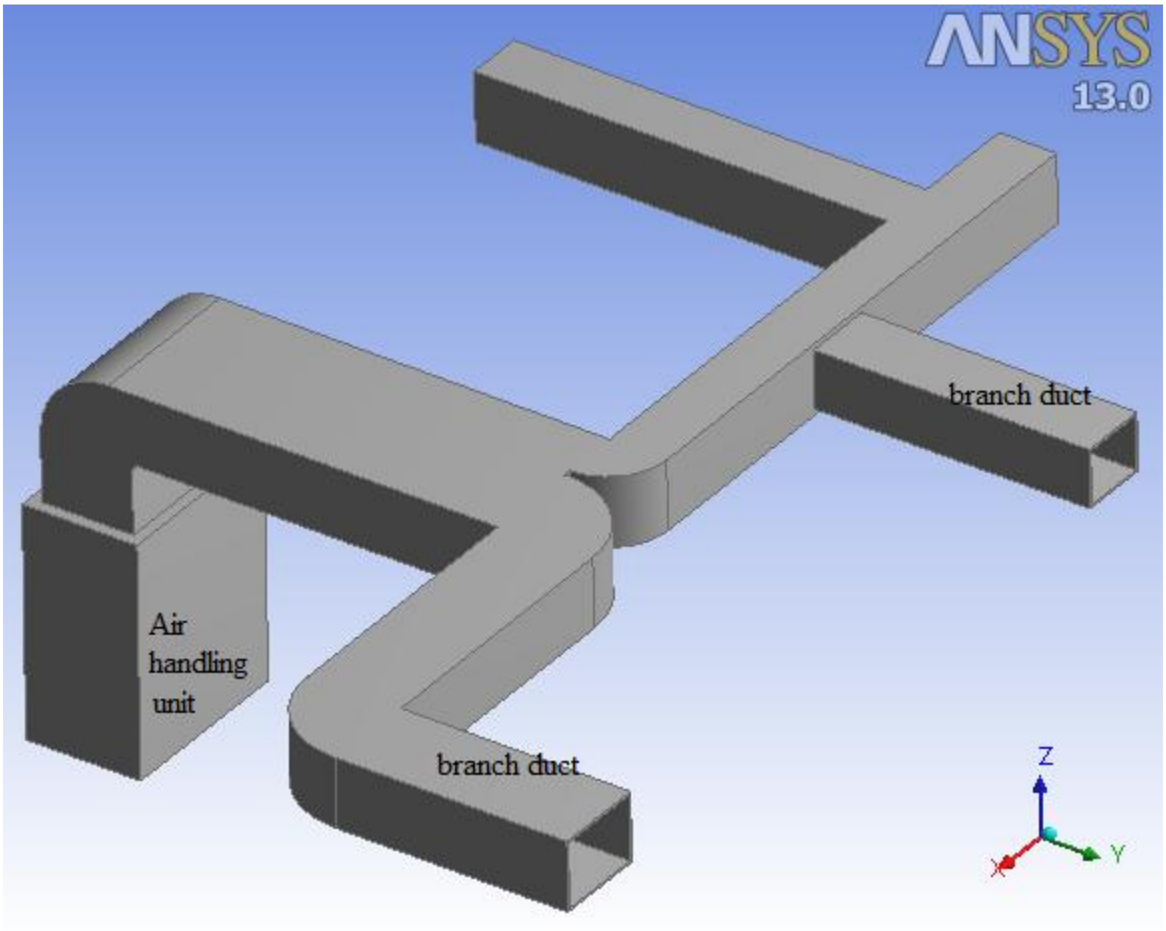


Fig 4 shows the overview of duct design model.

CONCLUSION

Now a day's materials of any project are to be light weighted and high strength. But we can take rigid glass fiber composite material with multilayer laminated board for air conditioning duct system. Because of this composite reduces loss about 20% of heating and cooling losses so material should be low thermal conducting material. We have made a material which has a low thermal conductivity composite as compare to others. Because of this composite is make with more than 2 materials. we want a material which has a low thermal conducting property. Some materials also have been made with a low thermal conducting. But we have made a material which is best compare to existing material. This composite can save up to 20% space from externally insulated duct. Let us compare 20 mm fiber glass rigid board with 25mm externally insulated duct, we can see nearly equal thermal conductivity. Result is given above table. This research is based on further selection and making of new material and analysis of heat transfer Thermal conductivity investigation.

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