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FLUID FLOW ANALYSIS OF E-GLASS AND HEMP FIBRE REINFORCED COMPOSITE PIPE JOINTS

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Abstract - *A composite material plays a vital role in material science research and it catches many applications but very less in oil and gases piping sectors. In the oil and gas industry, the pipelines transporting heavy crude oil are subjected to variable pressure waves causing fluctuating stress levels in the pipes. Fluid Flow Analysis was performed using Solid works software to study the effects of these pressure and velocity on some specified joints in the pipes In this work the comparison of various pipe joints was done by using glass fibre reinforced plastic and hemp fibre reinforced plastic composite material and the output result of the stress levels of the pipe joints were checked. Velocity and pressure flow of the straight pipe behaviour is normal in both Glass fibre reinforced plastic and Hemp Fibre-reinforced plastic. Similarly, the Velocity and pressure flow of the T-joint and Y-joint pipe the behaviour is maximum in Hemp fibre reinforced plastic when compared with Glass fibre Reinforced Plastic.*

***Key Words*: Composite, Fluid Analysis, Glass fibre and Hemp fibre reinforced plastics.**

1. INTRODUCTION

The most frequently used pipe systems for fluid transport are made of glass fibre reinforced plastic composites, also known as fiberglass composites. In other words, infrastructural industries can be considered as the pioneer for exploiting composite materials in preventing corrosion in chemically reactive environments and its consequent repair costs are the main reasons that different industrial sections have been encouraged to employ glass fibre reinforced plastic pipes [1]. Depending on the type of heavy crude oil being used, the flow behavior indicated a considerable degree of stress levels in certain connecting joints, causing the joints to become weak over a prolonged period of use. In this research comparison of various pipe joints was done by using different material and the output result of the stress levels of the pipe joints were checked so that the life of the pipe joints can be optimized by the change of material [2]. Off-shore oil and gas industry has great potential to drive economical research on innovative application of composite materials for long term benefits. This will be equally useful for industries in similar environment like off shore wind energy and marine engineering sector [3]. The development and application of a systematic and comprehensive approach for obtaining the most efficient meshes, described in terms of dimensionless parameters, for modelling pressurized water flows in pipes using Computational Fluid Dynamics [4]. The model geometry of three different pipe joints i.e. Elbow, T section, Y section and straight joints are created and flow of Kerosene were analyzed.

1.1 Objective of the Study

The objectives of the current study are:

i. Modelling of glass fibre reinforced plastic (GFRP) and hemp fibre reinforced plastic (HFRP) composites.

ii. Computational fluid flow analysis of kerosene in composite pipe joint (Straight pipe, Elbow, Y joint, and T joint).

iii. Comparing the velocity and pressure distribution of both composites.

2. Methodology

2.1 Geometry and Material properties

3D Geometry of the Elbow, Y joint, T joint and the straight pipe was modelled using Solidworks software and the common size of the pipe diameters are 20mm.

The modelling of various joints done by glass fibre reinforced plastic and hemp fibre reinforced plastic composites and shown in fig 1. The fluid used here was Kerosene.

(a)

(b)

(c) (d)

Fig -1: (a) Straight, (b) Elbow (c) T joint (d) Y joint

2.2 Pressure Analysis:

The pressure analysis of GFRP and HFRP composite is done with help of Solidworks software. The input of GFRP and HFRP was identified and then pressure analyses are done separately.

The input data are shown in table 1.

Table 1: Pressure Analysis Input

S.No.	Input Data	Values
1.	Fluid Type	Kerosene
2.	Input Pressure	101325 Pa
3.	Poisson's ratio	0.4
4.	Viscosity	650cps

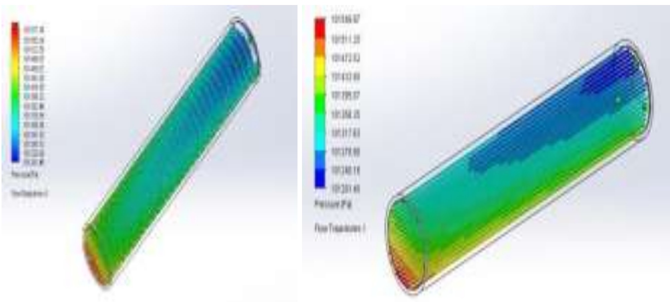

Fig 2: Pressure analysis of straight pipe in GFRP and HFRP

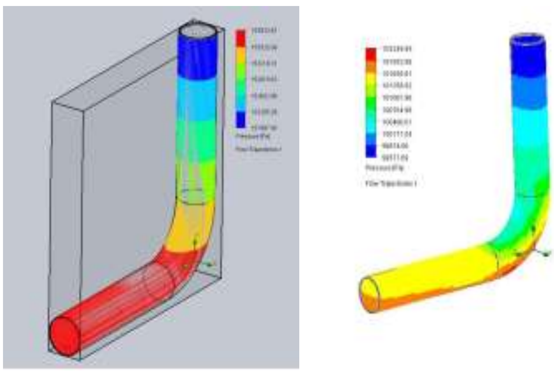

Fig 3: Pressure analysis of Elbow in GFRP and HFRP

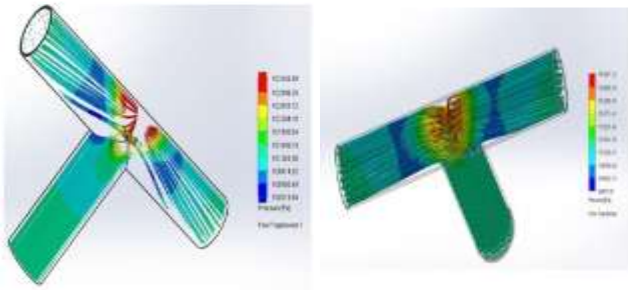

Fig 4: Pressure analysis of T joint in GFRP and HFRP

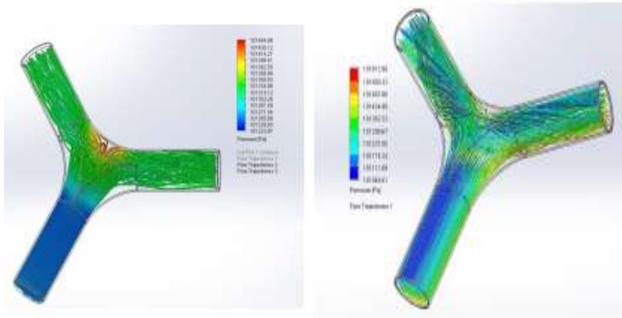

Fig 5: Pressure analysis of Y joint in GFRP and HFRP

The output of the pressure analysis of GFRP and HFRP are shown in fig 2 to fig 5.

2.3 Velocity analysis

Velocity analysis is to find the flow velocity character of a particular fluid. Velocity is important because it affects the time required to perform a fluid flow. The input data for velocity analysis is shown in table 2.

Table 2: Velocity analysis Input

S.No.	Input Data	Values
1.	Fluid Type	Kerosene
2.	Input Pressure	101325 Pa
3.	Poisson's ratio	0.4
4.	Velocity	3m/s
5.	Viscosity	650cps

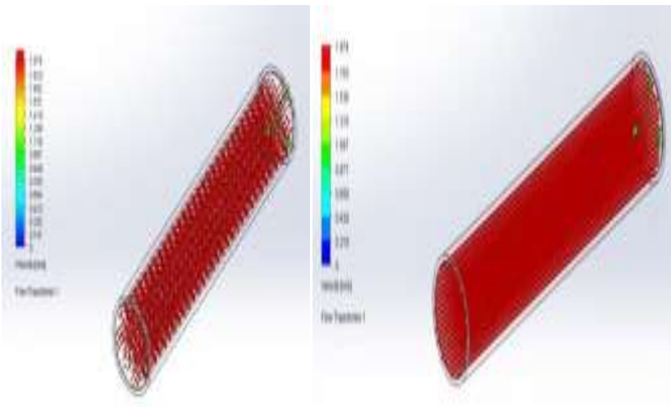

Fig 6: Velocity analysis of straight pipe in GFRP and HFRP

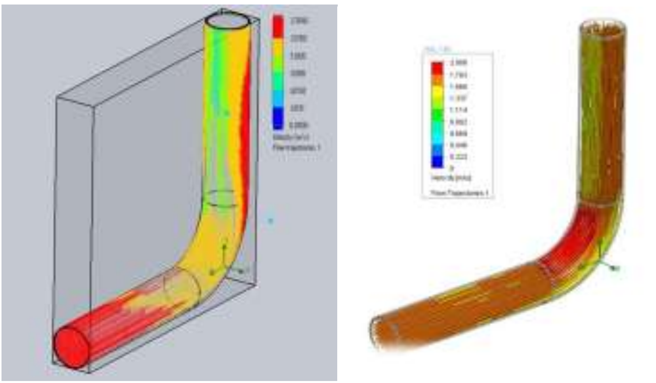

Fig 7: Velocity analysis of elbow joint in GFRP and HFRP

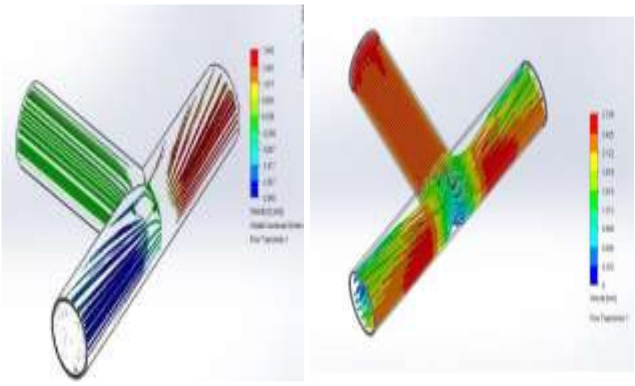

Fig 8: Velocity analysis of T joint in GFRP and HFRP

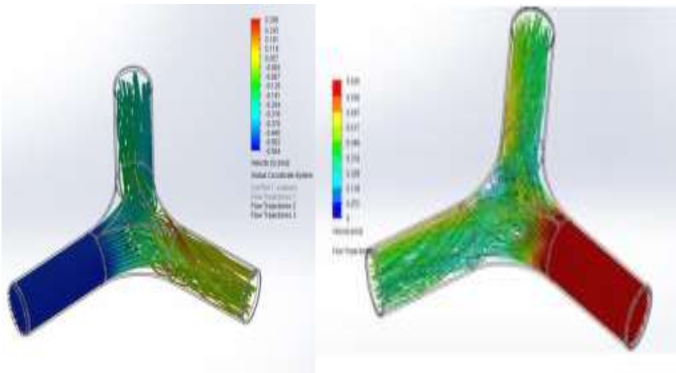

Fig 9: Velocity analysis of Y joint in GFRP and HFRP

The output of the velocity analysis of GFRP and HFRP is shown in fig 6 to 9.

3. RESULT AND DISCUSSION

Based on the result obtained from analyses of GFRP and HFRP for both pressure and velocity analysis of various joint output data are compared.

Table: 3 Pressure distributions of all types of joint

Type of joint	Fluid Flow Pressure (Pa) in GFRP		Fluid Flow Pressure (Pa) in HFRP	
	Max.	Min.	Max.	Min.
Straight pipe	101577.18	101201.45	101549.97	101201.45
Elbow	153833.67	151987.60	102249.85	99577.09
T joint	103346.80	100218.94	104321.22	99677.81
Y joint	101445.98	101223.97	101612.98	101049.0

In straight pipe the fluid pressure is 101577Pa in GFRP and 101549.97Pa in HFRP. It shows very little difference in the pressure of both composites.

The pressure flow analysis results show that the elbow as higher pressure range of 153833.67 Pa in GFRP when compared with HFRP, the pressure range slightly reduced to 102249.85 Pa it shows that HFRP is greater resistance of pressure in the elbow joint.

In T joint the fluid pressure developed against 1000 Pa is 103346.8Pa in GFRP and 104321.22Pa in HFRP composite it clearly indicates the pressure drop in T joint of and high pressure maintains in HFRP composite, it applied where the high pressure flow is required.

Similarly in Y joint also the pressure raises in HFRP composite of 101612.98Pa and in GFRP pressure slight lowered 101445.98Pa.

The pressure analysis shows that the T and Y joint have a greater impact on the pressure in HFRP composite but straight and elbow has slightly lower pressure than GFRP.

Since HFRP best suited for T and Y joint kerosene pressure flow. Straight and elbow GFRP composite is suited for kerosene flow.

Table: 4 Velocity analyses of all types of joint

Type of joint	Fluid Flow Velocity (m/s) in GFRP		Fluid Flow Velocity (m/s) in HFRP	
	Max.	Min.	Max.	Min.
Straight pipe	1.974	0	1.856	0
Elbow	2.264	0	2.531	0
T joint	2.650	0	2.728	0
Y joint	0.306	0	0.626	0

In straight pipe velocity flow of kerosene in GFRP and HFRP are 1.974 and 1.856(m/s) respectively. It shows HFRP more resistance to fluid flow.

In the elbow joint velocity increase in HFRP is 2.531m/s and reduced in GFRP composite of 2.264m/s.

Similarly the T and Y joint are higher velocity in HFRP composite are 2.728 and 0.626(m/s) respectively. Whereas in GFRP composite it is 2.650 and 0.306(m/s) respectively.

The velocity analysis shows that HFRP has a greater impact on T and Y joint it is best suited for high velocity.

Similarly straight and elbow has a lower variation of velocity in compared with GFRP of kerosene flow.

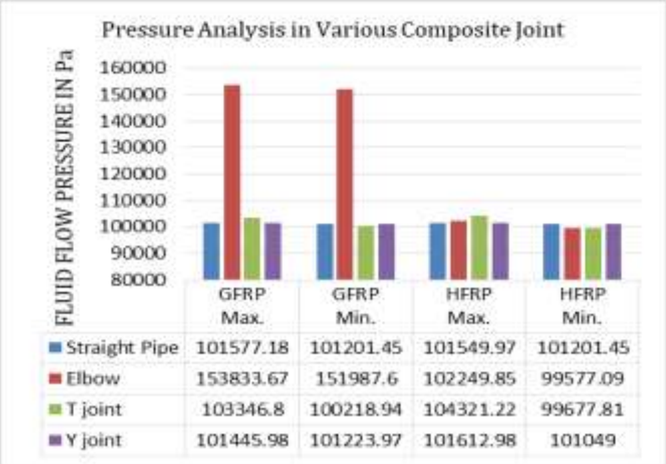

Fig 10: Pressure Analysis in Various Composite Pipe Joint

The fig. 10 shows that the maximum and minimum pressure ranges in the various joints of GFRP and HFRP composite. It is noted that HFRP composite joint is pressure resistant composite than GFRP hence HFRP has more capable to handle pressurised kerosene in various joints.

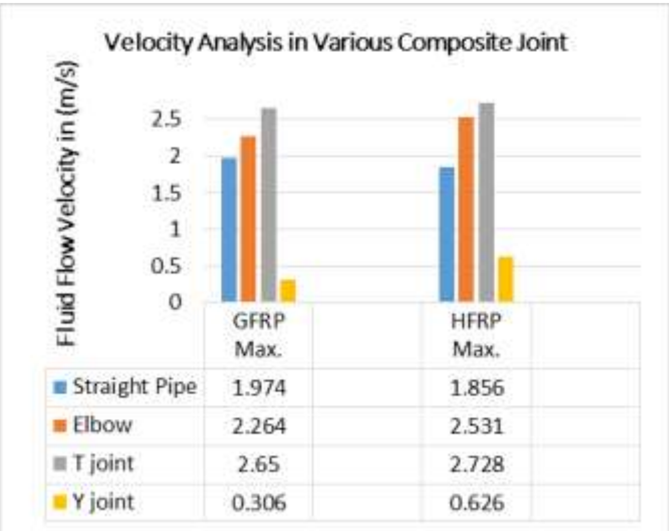

Fig 11: Velocity Analysis in Various Composite Joint

The fig. 10 shows that the maximum velocity ranges in the various joints of GFRP and HFRP composite.

Similarly, it clearly shows that HFRP straight pipe has velocity reduced than GFRP. Whereas HFRP Elbow and T joint have higher velocity than GFRP.

In Y joint velocity loss is twice in GFRP than HFRP composite. Since the HFRP has shown good result in compared with GFRP of kerosene fluid flow. It's because of composite properties and it also must be noted that HFRP has less impact with the environment.

Finally, it seems that HFRP is best suited for pressure and velocity based applications.

3. CONCLUSIONS

- Modelling of various Y joint, T joint, elbow joint and straight pipe by using Solid works was done.
- Kerosene was used as a fluid medium.
- Pressure and Velocity analyses of straight pipe, elbow, Y joint, and T joint were done by using Solid works.
- Pressure and Velocity flow of the straight pipe behaviour is normal in both GFRP and HFRP Composite.
- Pressure and Velocity flow of the T and Y joint behaviour is maximum in HFRP when compared to GFRP.
- In Y joint velocity loss is twice in GFRP than HFRP composite.
- HFRP is best suited for pressure and velocity based applications.

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