ANALYSIS OF GASOLINE FLOW INSIDE BRANCHED PIPE TO IMPROVED WALL SHEAR STRESS AND ACCESS PRESSURE WITH DIFFERENT MATERIALS USING DARCY WEISHBACH EQUATION

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Abstract — In present analysis the T – branch shaped pipe was used with three materials steel, mild steel and aluminium to create T – branched pipe edges were chamfered in different angles i.e. 30, 60, 45, 72 degrees the lean mixture of gasoline was set to be flow inside the pipe, sensors were attached in on pipe to analyse the effect of over pressure.

From this analysis it was found that mild steel pipe with 60 degree chamfered weld nugget has ability to resist higher over pressure compared to steel and aluminium, the numerical investigation was performed by using computational fluid dynamics analysis in fluent 15.0 domain for mild steel with 60 degree chamfered nugget weld the overpressure value converges the experimental values.

Keywords— *Steel, Mild Steel, Welding, T – Branch Shaped, Aluminum, Pipe, Gasoline, Lean Mixture, Over Pressure.*

I INTRODUCTION

INTRODUCTION

An explosion may be a fast increase in volume and unleash of energy in an extreme manner, typically with the generation of high temperatures and also unleash of gases. Supersonic explosions created by high explosives are referred to as detonations and travel via supersonic shock waves [8]. Subsonic explosions are created by low explosives through a slower burning method referred to as deflagration.

Natural - Explosions will occur in nature because of an outsized inflow of energy. Most natural explosions arise from volcanic processes of assorted types. Explosive volcanic eruptions occur once magma rising from below has a lot of dissolved gas in it; the reduction of pressure because the magma rises causes the gas to bubble out of resolution, resulting in a fast increase in volume.

Explosions additionally occur as a results of impact events and in phenomena like hydrothermal explosions (also because of volcanic processes). Explosions may occur outside of Earth within the universe in events like supernova. Explosions often occur throughout bushfires in eucalyptus forests wherever the volatile oils within the tree topnotch suddenly combust.

Astronomical - Among the biggest better-known explosions within the universe are supernovae, which end once a star explodes from the sharp beginning or stopping of nuclear reaction, and electromagnetic radiation bursts, whose nature continues to be in some dispute. Star flares are associate example of common explosion on the Sun, and presumptively on most different stars also.

The energy supply for solar radiation activity comes from the tangling of magnetic flux lines ensuing from the rotation of the Sun's semi-conductive plasma. Another form of giant astronomical explosion happens once an awfully giant extraterrestrials body or associate asteroid impacts the surface of another object, like a planet.

Chemical -The most common artificial explosives are chemical explosives, sometimes involving a fast and violent oxidization reaction that produces massive amounts of hot gas. Gun-Powder was the primary explosive to be discovered and place to use. Different notable early developments in chemical explosive technology were Frederick Augustus Abel's development of nitrocellulose in 1865 and Alfred Nobel's invention of dynamite in 1866 [20]. Chemical explosions (both intentional and accidental) are typically initiated by an electrical spark or flame within the presence of oxygen. Accidental explosions might occur in fuel tanks, rocket engines, etc.

Electrical and magnetic

A high current electrical fault will produce associate 'electrical explosion by forming a high energy electrical arc that quickly vaporizes metal and insulation material. This arc flash hazard may be a danger to persons functioning on energized switchgear. Also, excessive magnetic pressure inside associate ultra-strong electromagnet will cause a magnetic explosion.

Mechanical and vapor

Strictly a physical method, as opposition chemical or nuclear, e.g., the explosive of a sealed or partly sealed instrumentality underneath internal pressure is commonly mentioned as a 'mechanical explosion'.

II EVOLUTION OF HEAT

The generation of warmth in massive quantities accompanies most explosive chemical reactions. The exceptions are referred to as entropic explosives and embody organic peroxides like propanone peroxide [2]. It’s the speedy liberation of warmth that causes the gaseous merchandise of most explosive reactions to expand and generate high pressures. This speedy generation of high pressures of the discharged gas constitutes the explosion.

The liberation of warmth with short quickness won't cause associate explosion. for instance, though a unit mass of coal yields five times the maximum amount heat as a unit mass of nitroglycerine, the coal cannot be used as associate explosive (except within the kind of coal dust) as a result of the speed at which it yields this heat is kind of slow. In fact, a substance that burns less quickly (i.e. slow combustion) may very well evolve a lot of heat content than associate explosive which detonates quickly (i.e. quick combustion).

III FLAME SPEED

The flame speed is that the measured rate of enlargement of the flame front in a very combustion reaction. Whereas flame speed is usually used for a fuel, a connected term is explosive speed, which is that the same relationship measured for associate explosive [26]. Combustion engineers differentiate between the laminar flame speed and turbulent flame speed.

Flame speed is often measured in m/s, cm/s, etc. it's acknowledge that explosions of flammable gases within the method trade are still a significant drawback resulting in injuries, death, destruction of apparatus and downtime. So as to push the flexibility of protective the chemical processes from being destroyed by unwanted explosions, a significant of experimental and numerical studies are disbursed by some scientific analysis teams but, there's still an extra would like for exploring the mechanisms and laws of combustion and explosion, like the flame propagation characteristics, ignition laws, overpressure amendment laws, {chemical reaction or chemical method or chemical change or chemical action} process, heat unharness laws, etc. Former studies have found that the geometric structures of confined areas had significant effects on the explosion characteristics like the most overpressures, the overpressure rise rates, and flame speeds

IV OVER-PRESSURE

Overpressure (or blast overpressure) is that the pressure caused by an undulation over and on top of traditional gas pressure. The undulation could also be caused by sonic boom or by explosion, and therefore the ensuing overpressure receives specific attention once measure the consequences of nuclear weapons or thermobaric bombs [2].

Effect of Over-Pressure

Blast overpressure (BOP), conjointly referred to as high energy impulse noise, and could be a damaging outcome of explosive detonations and firing of weapons. Exposure to BOP shock waves alone leads to injury preponderantly to the hollow organ systems like sense modality, metabolic process, and gastrointestinal systems.

V PIPELINE NETWORK & TRANSPORTATION

Pipe networks are principally used for transportation and provide of fluids and gases. These networks vary from fewer pipes to thousands of pipes. Additionally to pipes, the network conjointly consists of elbows, T-junctions, bends, contractions, expansions, valves, meters, pumps, turbines and plenty of different elements. These elements cause loss in pressure because of modification in momentum of the flow caused because of friction and pipe elements [6]. This implies conversion of flow energy in to heat because of friction or energy lost due to turbulence.

Pipe networks are quite common in industries, wherever fluid or gases are to be transported from one location to the other. The top (head) loss (pressure loss) might vary looking on the kind of elements occurring within the network, material of the pipe and kind of fluid transported through the network. In industries the networks are sometimes massive and need terribly precise pressure at sure points of network. It's additionally generally essential to put valves, pumps or turbines of sure capability to manage pressure within the network [14]. The position of valves, pumps and turbines is very important to beat pressure loses caused by different elements within the network. This can be one in all the vital reasons why this study was conducted

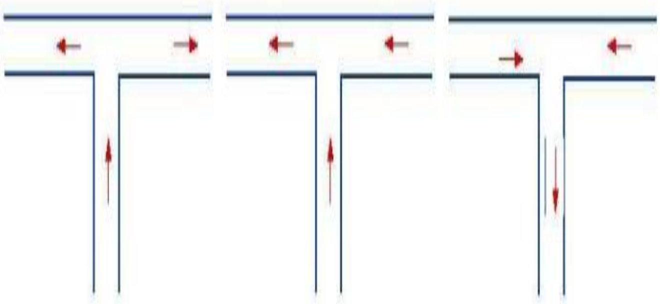


Figure 1.1: Numerous Chances of Entering and Leaving (Fluid) the junction [14]

VI LITERATURE REVIEW

[1] Peili Zhang et al: Through the first law of thermodynamics, the adiabatic temperature and overpressure of the isooctane–air explosion under constant volume condition were theoretically calculated. Combined with the experiments of gasoline vapor explosion in the standard 20-L spherical vessel, the errors between the experimental explosion overpressure of the gasoline vapor and its theoretical calculation value of the isooctane at the same equivalence ratio were compared. Results show that when $\phi \leq 1$, the gap between the experimental value and the theoretical value is a small constant of 0.126 MPa. However, when $\phi > 1$, the gap increases with the increase in ϕ and linearly related to ϕ. Based on the error analysis, an equivalent relationship for the constant volume explosion overpressure of the gasoline vapor and the isooctane was finally put forward. This relationship not only can be used to accurately predict the overpressure of the gasoline vapor–air mixture explosion at any gasoline vapor volume concentration, but also can be used to modify the gasoline explosion overpressure calculation model

and enable the errors between the model's calculation value and the actual experimental value to be significantly reduced.

[2] Nakayama J et al: In this study, they attempted to estimate the thermal hazards related to the MCH dehydrogenation system using TAM IV, DSC, TG, and C80 measurements. The results obtained can be summarized as, under normal operating conditions, the thermal hazards of MCH, toluene, and the heat carriers are very low, and the dehydrogenation system can be operated safely.

Under abnormal operating conditions, thermal hazards exist, and minor incidents can occur. However, fatal accidents are less likely. The leakage of the heat carriers can be likely to cause the spontaneous ignition of the heat carrier system. Therefore, regular and thorough inspections of the system are essential. Process safety assessments of the dehydrogenation system must be included at the design stage based on the thermal hazard data obtained in this study.

[3] Qi S and Du Y et al: An experimental investigation was carried out on the influences of equivalence ratios on gasoline–air mixture deflagration in a closed vessel; high-speed flame images, flame illuminance, illumination duration, overpressure, and reaction products were recorded over equivalence ratios of 0.54 (below the lower limit) to 2.10 (beyond the higher limit). It has been found that the gasoline–air mixture deflagration in a confined space exhibits a smooth spherical flame in the range of $0.68 < \phi < 0.97$ (lean fuel), a spherical cellular flame in the range of $1.06 < \phi < 1.29$ (rich fuel), and a curled flocculent flame in the range of $1.49 < \phi < 1.85$ (very rich fuel). The maximum flame illuminance, illumination duration, reaction products, rate of pressure rise, and maximum pressure showed discriminating value and variation trends versus equivalence ratio under different flame patterns. By calculating the edge pixel amounts and the average b* value (in a Lab color space) of the flame images, the flame patterns could be quantitatively identified. This indicates that the digital image, which contains a deflagration flame, could be used to roughly distinguish the equivalence ratio of the reacting gas mixture.

[4] Mitu M and Brandes E et al: Investigation on explosion pressures including maximum explosion pressure, explosion pressure rise including maximum explosion pressure rise, explosion delay times and burning velocities including maximum burning velocities of ethanol/(air + diluent) mixtures) allow the following conclusions:

Concerning the amount of inert gas added the maximum explosion pressure and the maximum explosion pressure rise occur at the same mixture composition, independent of the amount of diluent and the diluent investigated. It is possible to estimate the ethanol concentration with the diluted mixtures where the maximum explosion pressure occurs. Although up to 20 Vol% inert added linear correlations between the amount of inert added and explosion pressure or explosion pressure rise mirror the influence of the inert added around stoichiometric ethanol/air-mixtures, estimation of the limiting oxygen concentration by this way seems not to be precise enough. One reason for this may be that near to the mixture composition where the limiting oxygen concentration is found experimentally additional facts like the criterion for a starting rapid oxidation reaction (explosions) or the changing flame temperature play an important role.

The effectiveness of the investigated inert gases correlates roughly with the coefficient of nitrogen equivalency which mirrors the effect of the respective heat capacities and heat conductivity on the mass reaction rate via influencing the flame temperature.

[5] Luca Motoc D et al: The paper aimed to develop, investigate, and debate the overall temperature related behavior of differently stacked sequences of synthetic- (i.e., CF/BF) and natural- (i.e., FF) fiber-reinforced laminates. The novel thermosetting cyanate ester formula proved to fulfill adhesion criterion and easiness during handling while deployed as the matrix for the laminates, spawning high-quality surface samples. The synergetic effects, due to individual synthetic or natural reinforcements and various stacking sequences, were debated accounting on the effective thermos physical properties (i.e., thermal expansion, thermal conductivity) and thermal decomposition processes.

The conclusions from this study can be thought to apply to a broad range of lignocellulosic reinforcements (e.g. kenaf, ramie, hemp, coir, jute) by stacking similarly in combination to carbon or basalt fibers or accounted for other hybrid composite architectures.

[6] Zhang Q et al: The numerical simulations have been conducted for cloud explosion of the hydrogen/air, propane/air, and methane/air at the stoichiometric volume fractions (i.e., 9.5 Vol. %, 4 Vol. %, and 30 Vol. %, respectively for methane, propane, and hydrogen). The explosion characteristics of the hydrogen/air, the propane/air, and the methane/air have been compared based on the numerical results. Under the calculation conditions in this study, the main conclusions drawn can be summarized as follows.

1. The explosion of hydrogen/air cloud has higher peak overpressure and the overpressure rises locally at the nearby region of the cloud boundary. Similarly, the maximum rate of overpressure rise for the hydrogen/air cloud explosion increases locally at the nearby region of the cloud boundary. The explosion overpressures of both the methane/air and the propane/air examined in this study are lower and decreases with distance.
2. The maximum peak dynamic pressure is reached beyond the original cloud, which is clearly different from the peak explosion overpressure tendencies. Furthermore, dynamic pressure of a cloud explosion is of the same order as overpressure. The hazard effect of explosion dynamic pressure should not be ignored.
3. The explosion flame regions for the propane/air or the methane/air are approximately 1.4 times of the original width of the cloud. The explosion flame region for the hydrogen/air is approximately 1.25 times of the original width of the cloud. Unlike the explosion overpressures, the explosion temperatures at various locations have little difference between the three mixture examined in this study.
4. The higher energy of explosive mixture generates a larger high temperature hazard effect in a gas explosion accident. But, the higher energy of explosive mixture may not generate a larger overpressure hazard effect.

[7] Guoqing Li and Yang Du et al: Contrast experiments were carried out in this paper to explore the effects of T-shaped branch structure on the overpressure, average overpressure rise rate and

flame speed of gasoline-air mixtures explosion in a closed pipe.

It was shown that the maximum overpressures both in the straight pipe and the pipe with a T-shaped branch structure increased with the growth of distance from the ignition point. Oscillations were seen during the flame development in the straight pipe and the pipe with a T-shaped branch structure. The maximum flame speeds were found in the range of 52 % - 63 % of the pipe length for the straight pipe, and 59 % - 64 % of the pipe length for the pipe containing a T-shaped branch structure. It was also discovered that the T-shaped branch structure placed in the middle of a closed pipe had the ability to enhance overpressures, average overpressure rise rates and flame speeds, and it had little effect on the upstream flow, but much on the downstream flow. When initial concentration was at 1.7% (close to the stoichiometric ratio), the degree of enhancement was more significant than 1.3% (lean concentration) and 2.3% (rich concentration). When the flame propagated through the section of T-shaped branch structure, distorted and wrinkled flame fronts could be observed, which increased the flame surface area, thereby increasing the burning rate, heat release and enhancing the flame speed. This work has contributed further to the argument that T-shaped branch structure in a pipe has a significant effect on the combustion and explosion process of flammable gases, and when placing explosion suppression devices, flame arresters and venting devices during an industry process, this structure should be taken into account as part of safety analysis. Although some meaningful results were found in this study, there are still many problems unsolved in this paper like the effects of T-shaped branch structure position, multiple branch, ignition energy and so on.

VII MODELING AND ANALYSIS

The procedure for solving the problem is:

Create the geometry.

- Modeling of the geometry.
- Meshing of the domain.
- Defining the input parameters.
- Simulation of domain.

Preprocessing

Preprocessing include CAD model, meshing and defining boundary conditions.

CAD Model

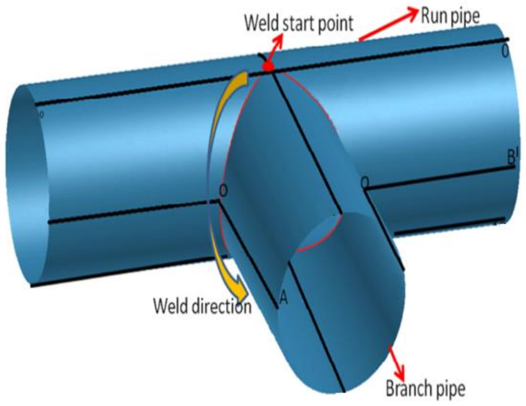


Figure CAD model of T – branch shaped pipe

Meshing

The group of nodes and elements is known as meshing this process is done to determine convergence of solution the phenomenon convergence of solution is a relation between accuracy, degree of freedom and no. of nodes and elements as the quantity of nodes and elements are increased at variable iteration a convergence of solution is obtained.

Meshing are of different types i.e. Tetrahedral, Quadrahedral, Hexahedral, Square mesh and triangular mesh, tetrahedral mesh gives better convergence during finite element simulation a stiffness matrix, damping matrix, stress matrix is solved on ANSYS at each and every node and element by iteration methods like runge-kutta etc. to determine convergence of solution.

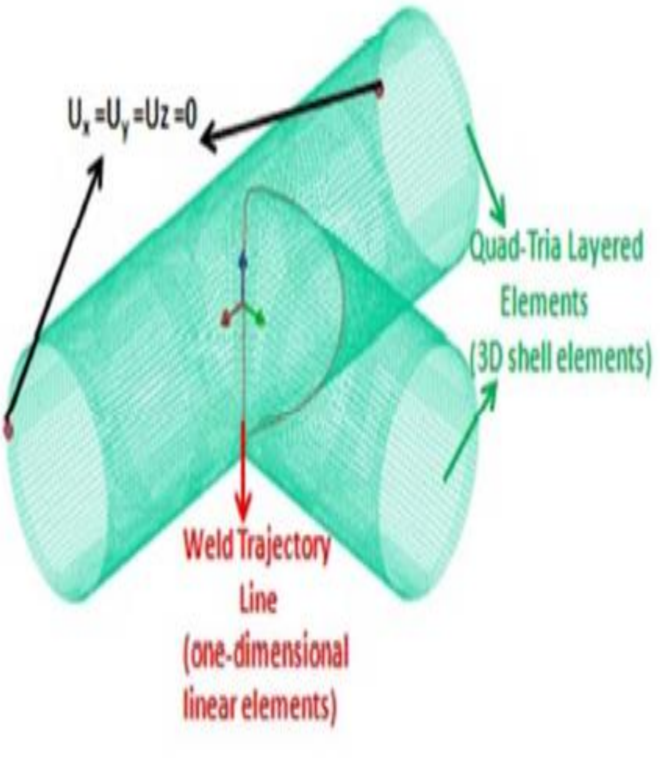


Figure Meshing domain of CAD model of T – branch shaped pipe

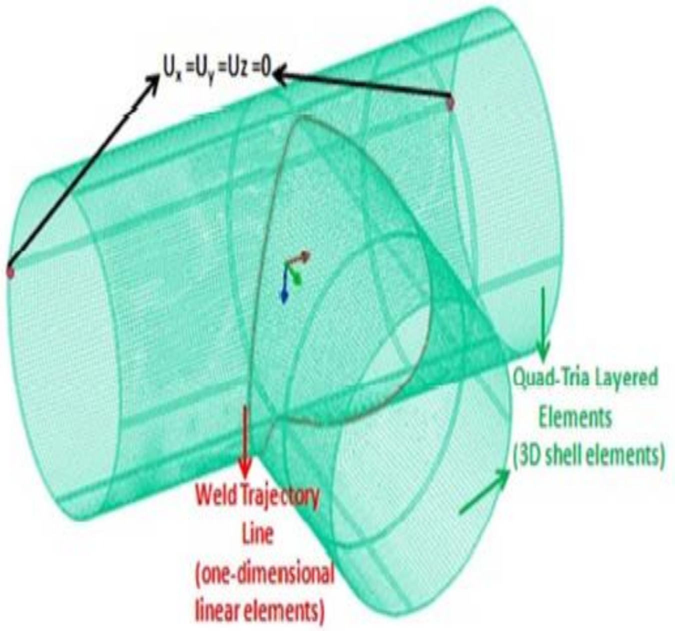


Figure: Meshing domain of CAD model of T – branch shaped pipe.

VIII RESULT AND DISCUSSION

ANALYSIS OF T – BRANCHED SHAPE STEEL PIPE WITH CHAMFER ANGLE OF 30 DEGREE TO 72 DEGREE

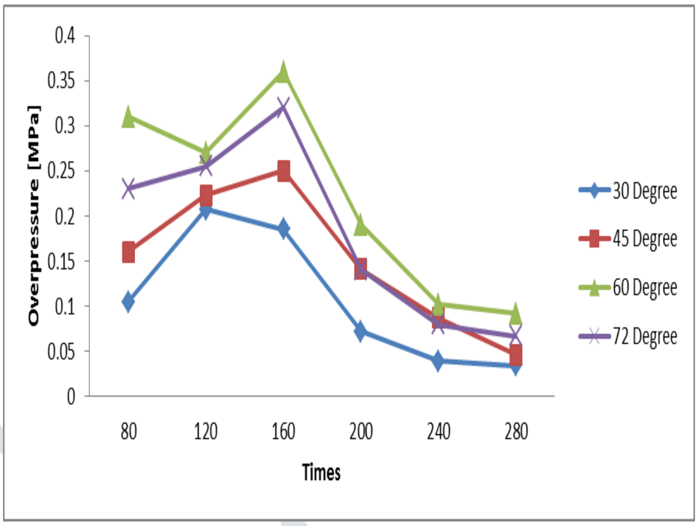
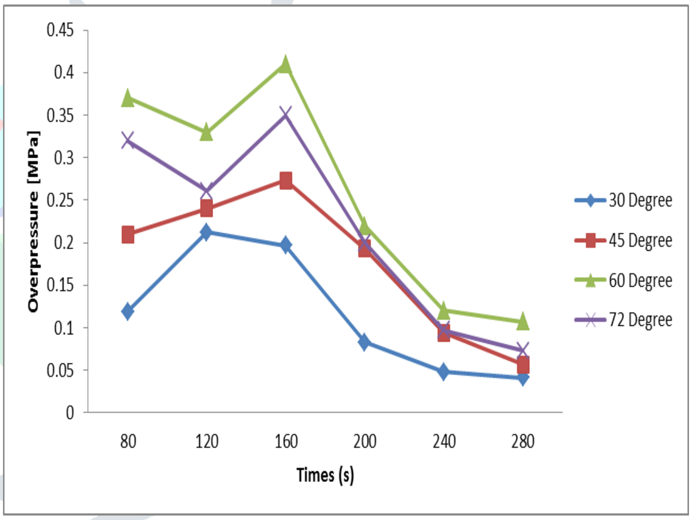


Figure Shows the comparison of overpressure values with respect to Time (s) in different chamfer angle



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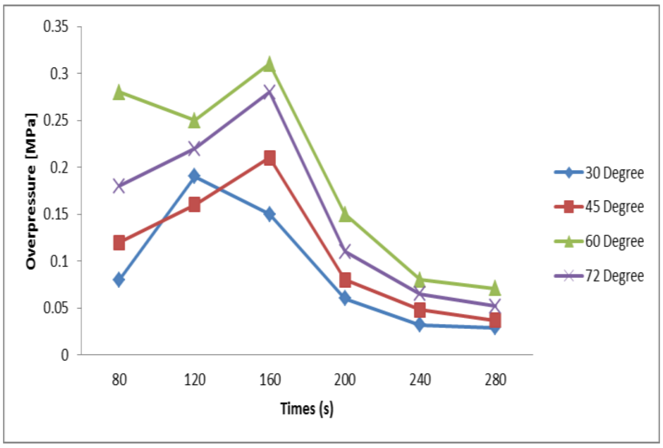

Figure: Shows the comparison of overpressure values with respect to Time (s) in different chamfer angle.

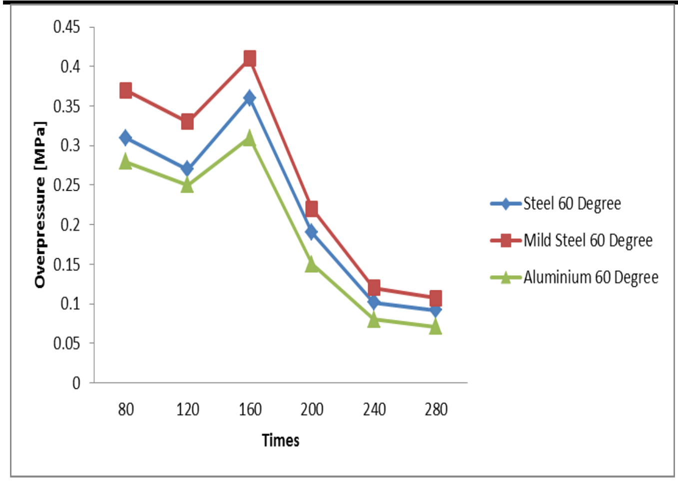

Figure Represents the comparison of optimum results of overpressure between all materials and angles

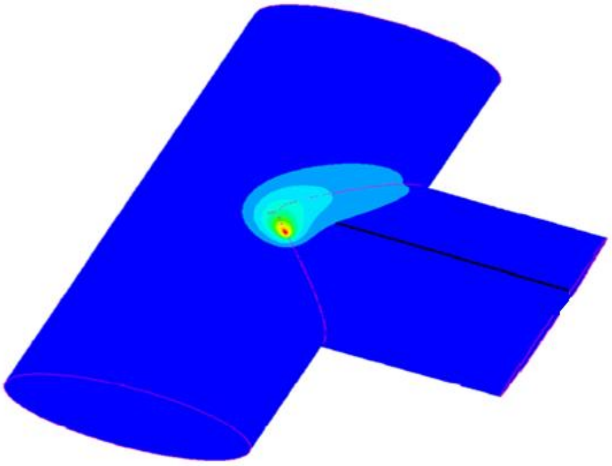

Figure Contour plot represents the concentration of over pressure at different zones of T – branch shaped pipe.

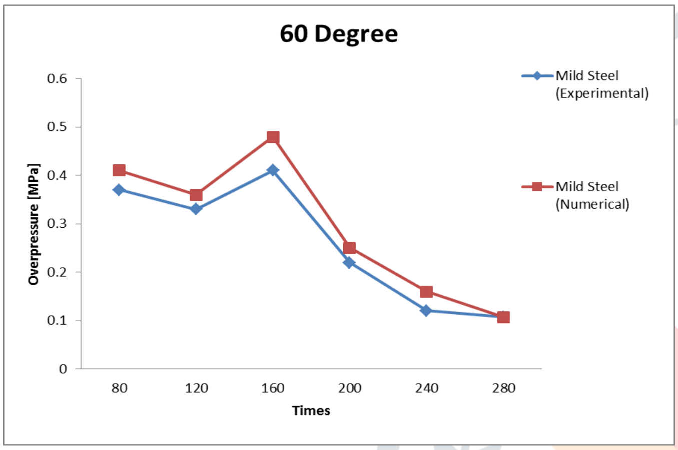

Figure Comparison of experimental and numerical simulation of high strength chamfer angle over pressure

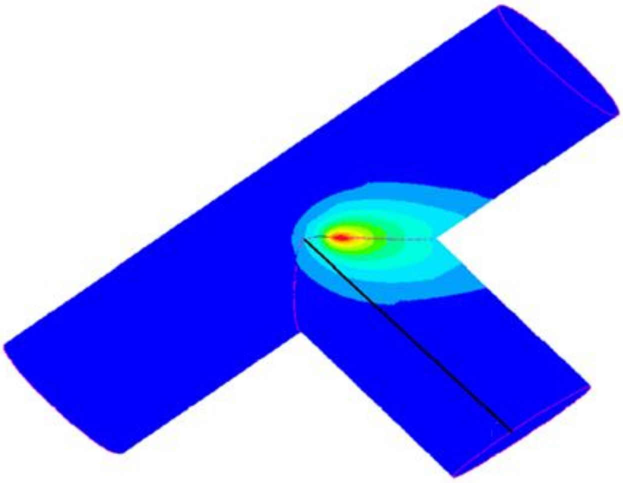

Figure Contour plot represents the concentration of over pressure at different zones of T – branch shaped pipe

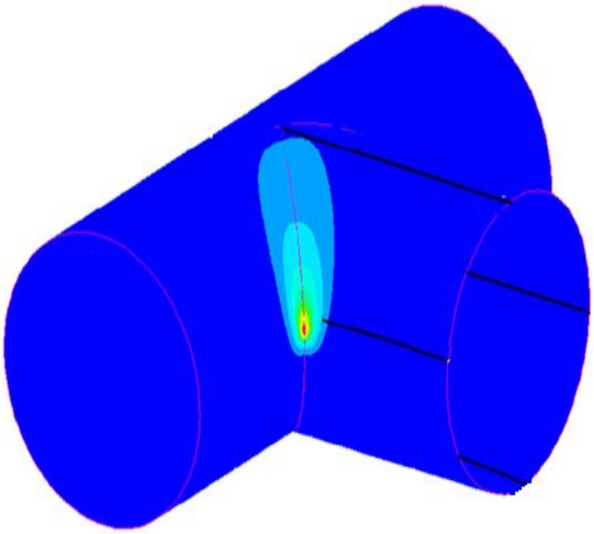

Figure Contour plot represents the concentration of over pressure at different zones of T – branch shaped pipe

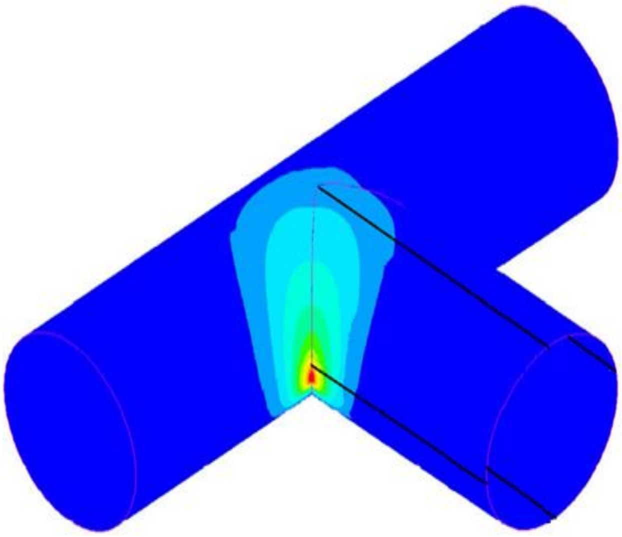

Figure Contour plot represents the concentration of over pressure at different zones of T – branch shaped pipe

IX CONCLUSION

The overpressure effect is found to be maximum for the mild steel material profile with welded nugget of 60 degree chamfered welded zone. The overpressure ability is found maximum for mild steel.

The magnitude of lean mixture in the case of 60 degree chamfered nugget T – branch shaped pipe was found to be high compared to steel and aluminum.

The nature of wall fluxes is found to be optimum.

In a comparison with the gray cast iron of all three modes i.e. opening mode, shearing mode and tearing mode the stress intensity factor for butt joint is found maximum and minimum for lap joint with different nugget shape, thus it would be concluded that lap joint with flush shape nugget shows less frictional stress as well as minimum effect of stress intensity factor thus effect of fatigue failure is found less thus this design of component could be used for the purpose of joining plates variable purposes.

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