**Technical Report**

# Effect of Mass of Flowing Oil on Its Erosional Velocity and Corrosion in Pipeline

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**Abstract**: Studies carried out to investigate the effect of mass of flowing oil on its erosional velocity and corrosion in pipeline. The result of the investigation reveals that increase in both volume of oil flow and internal radius of pipeline increases the erosional velocity and invariably enhance erosion corrosion due to mechanical wears resulting from relative movement between the fluid and wall of the pipe. It was discovered that increase in mass of flowing oil slows down the erosional velocity due to the gliding effect of oil particles on each other, hence reducing the tendency for erosion corrosion. [Report and Opinion. 2010;2(1):43-45]. (ISSN: 1553-9873).

**Keywords**: Effect, Flowing Oil, Erosional Velocity, Corrosion, Pipeline System.

## 1. Introduction

Erosion corrosion has been reported (Ijomah, 1991) to be a localized attack associated with turbulent flow. It is characterized by pits, grooves or rounded holes which often exhibits directional pattern. Mechanical wear or abrasion is involved owing to the relative movement between the fluid and the metal surface. This type of corrosion is observed in pumps, valves, orifices, protrusions and at elbows and tee joints of pipelines. The nature and properties of the protective films that form on some metal and alloys are very important for erosion corrosion resistance. It was found (Ijomah, 1991) that he ability of these films to protect the metal depends on the speed or ease with which they form when originally exposed to the environment, their resistance to mechanical damage or wear and their rate of reforming when damaged or destroyed. Many failures resulting from erosion corrosion have been attributed to impingement effect i.e the fluid impinges upon the metal surface, particularly where it is forced to change direction (Ijomah, 1991). This frequently occurs at elbows or tee joints of pipelines or other similar applications where impingement condition exists, particularly under turbulent conditions. Entrained solid particles, gases or air bubbles tend to accelerate impingement attack. The entrained solids enhance mechanical abrasion while entrained gases increase turbulence.

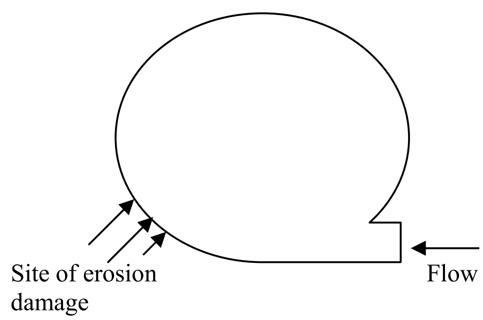


Figure 1. Erosion corrosion (impingement attack) of a curved line

## 2. Materials and methods

In this study, work was carried out on the major oil pipeline; PPL 1 at offshore platforms in South Southern State of Nigeria, having been certified corrosion infested. Varied volumes of oil flow, internal radius of pipeline and mass of flowing oil were obtained and the corresponding erosional velocity determined by calculation. Values from these parameters were critically analyzed and used for deriving vital conclusions. Details of the experiment are as stated in the report (Nwoye, 2008).

Table 1: Parameters use

| Parameters used | Values |
|---|---|
| Medium (Crude oil) | - |
| Average Operating Temperature | $97^0F$ |
| Internal Diameter | 1.2-1.97 ft |
| Emperical Constant | 0.85 |
| Total length of pipe | 3780 ft |

Most metals depend on the formation and maintenance of a protective scale for corrosion resistance. Removal of this scales at local areas lead to accelerated attack. High velocity flow or turbulence can erode away the protective scale to expose fresh water to corrosive attack. The combination of the erosion of the scale and corrosion of the underlying metal is termed Flow Enhanced Corrosion. Erosional velocity limit for any oil or gas piping is calculated from the equation Udeme, 1998);

$$V_e = \left( \frac{C}{(P_m)^{1/2}} \right) \quad (1)$$

$$\rho = m / v = P_m \quad (2)$$

Substituting equation (2) into equation (1)

$$V_e = \left( \frac{C}{(m/v)^{1/2}} \right) \quad (3)$$

$$V_e = \left( \frac{C\, v^{1/2}}{m^{1/2}} \right) \quad (4)$$

$$V_e = \left( \frac{C \sqrt{v}}{\sqrt{m}} \right) \quad (5)$$

Since the pipeline is cylindrical,
The volume of flowing oil is given by;

$$V = \Pi r^2 h \quad (6)$$

Substituting equation (6) into equation (5)

$$V_e = \left( \frac{C \sqrt{\Pi r^2 h}}{\sqrt{m}} \right) \quad (7)$$

Where

$V_e$ = Erosion flow velocity (ft/sec)
$P_m$ = Fluid/mix density ($lb/ft^3$)
C = Emperical constant
r = Radius of the pipeline (ft)
h = Length of the pipeline (ft)

**3. Results and discussion**

Figure 2 shows that increase in the volume of oil flowing through the pipeline increases the erosional velocity. This is due to increased relative movement between the fluid and the wall of the pipe, resulting to mechanical wears and abrasion. This is in accordance with past report (Ijomah, 1991). Furthermore, increased volume of oil flow increases the frictional force resisting the flow in the direction opposite the actual direction of flow of the oil thereby causing mechanical wears. This wears eventually result to erosion corrosion; characterized by pit, grooves which often exhibit a directional pattern.

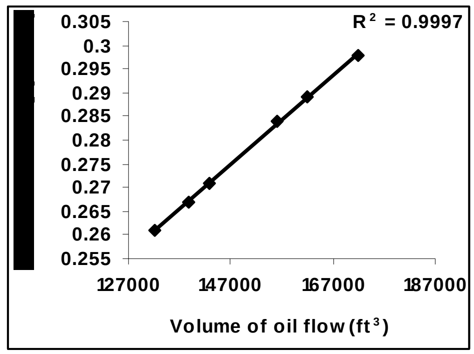


Figure 2. Effect of volume of flowing oil on the erosional velocity

Analysis of Figure 3 shows that increasing the mass of flowing oil at constant volume of oil flow reduces erosional velocity. This is because increasing the mass of flowing slows down its velocity of movement as oil particles glides on each other. The resultant effect is that the frictional force called into play decreases and hence reduces mechanical wears or abrasion.

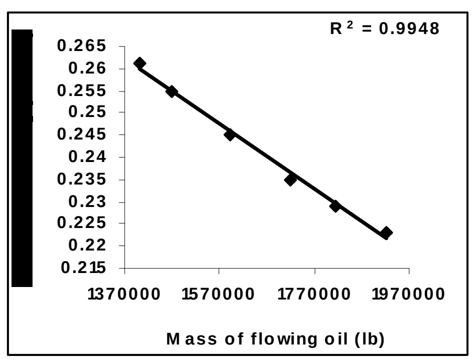


Figure 3. Effect of mass of flowing oil on the erosional velocity

Critical analysis of Figure 4 shows that increase in the internal radius of the pipeline increases the erosional velocity. This is because increased radius reduces the gliding effect of the oil particles on each other by offer them less restricted movement. This way, the velocity of flow of the oil increases resulting to mechanical wears or abrasion.

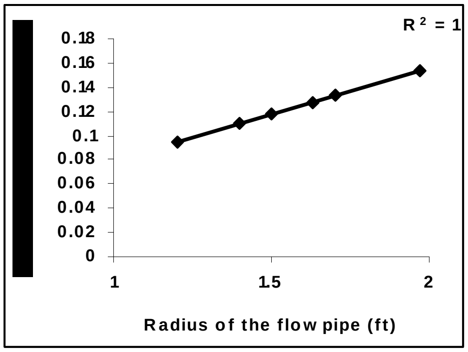


Figure 4. Effect of radius of flow pipe on the erosional velocity

## 4. Conclusion

Studies carried out to investigate the effect of mass of flowing oil on its erosional velocity and corrosion in pipeline. Increase in both volume of oil flow and radius of pipeline increases the erosional velocity and invariably erosion corrosion. Increase in mass of flowing oil reduces the erosional velocity due to the gliding effect of oil particles on each other.

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