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OIL LEAKAGE DETECTION USING TEMPERATURE CHANGING TECHNIQUE

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ABSTRACT

Photonic Crystal Fiber PCF which is another kind of optical fiber is appeared by Russell. It can beat various obstruction of customary optical fiber, PCFs are uncommon class of optical fiber can be delivered utilizing single material (silica). In this paper LMA-10 PCFS is used, with different lengths as takes after; (2, 2.5, and 3) cm by Fujikura (FSM 60) blend graft machine LMA-10 PCF lengths are joined. The sensor transmission run is checked with laser diode 850 nm sources and OSA as optical range analyzer through sensor fabricating.
The experimental result demonstrate that the temperature changing strategy is conversely corresponding with the outside force and the best affectability found for this system is around 0.42 for metal and 0.18 for polymer.

KEYWORDS: Optical fiber, Photonic Crystal Fiber PCF, Oil leakage detection, Temperature changing.

I. INTRODUCTION

Optical fibers have a great fundamental structure. When all is said in done optical filaments involve two fragments the first is the silica glass center which its refractive file n1, while the other layer is the cladding layer which its refractive list n2 is littler than that of the center. Furthermore, this distinction in the refractive lists makes the light be guided in the aggregate inside reflection [1]. Two sort of optical fiber are energized depending upon modes number and round and hollow structure: single mode fiber SMF which comprise of single mode and it varies in center breadth from the multimode and it has little center measurement equivalent to (5 - 10 microns) while multimode fiber MMF which comprise of numerous mode and its center distance across is bigger than single equivalent to (50 or 62.5 microns) [2].
Many sorts of optical fiber sensors have been considered to gage different parameters. Another sort of optical fiber is showed up by Russell is Photonic crystal fiber PCF. It can beat different deterrent of standard optical fiber , PCFs are exceptional class of optical fiber can be delivered utilizing single material (silica) , its geometry is featuring by uncommon game plan of air-opening that running along entire length of fiber , by solidifying the properties of both optical filaments and photonic precious stones [3].
There are two sort sorts of PCFs: praise center where the light aides will be through the photonic band hole and the strong center sort where the light aides will be through the aggregate interior reflection [4]. PCF sensors are to a great degree arresting and good class of sensors has emerged. Oil pipe spillage sensor can be worked by using Interferometers systems with photonic precious stone fiber.
Pipe line watching frameworks for spill, ground advancement, and intrusion identification are a bit of new pipeline ventures. Using appropriated fiber-optic sensors to recognize spillage can be a comprehensive response for perpetual, in-line, constant checking of various pipelines. To accomplish a mass adjust where in secured pipelines, the visual appraisal isn't possible, the most broadly perceived method is checking stream, weight, and temperature to play out a mass alter. Notwithstanding the way that this methodology is by and large fruitful at detecting colossal spillage, it can't pinpoint the right area of a spillage so it is consistently used as a piece of conjunction with various procedures [5, 6].
The primary parameter to consider in a Single Mode Fiber SMF is the measurement of center, while there are three physical parameters in a PCF to effectively set:

1. The ring diameter as known in solid core PCF, which is shaped by deepest air holes.
2. The air holes diameter *d* of the cladding
3. And the pitch Λ.

Distinctive leak discovery frameworks including both the equipment and programming based strategies based methods are being used by pipeline executives the Classification of Oil/Gas leak recognition frameworks in light of their specialized nature [7, 8 and 9].

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In view of criteria grouping the Pipeline spill discovery methods can be ordered. They move from human visual appraisal to equipment based sensors to the control frameworks based, ceaseless watching. Each approach has its qualities and weaknesses. The operational standard, data and hardware prerequisites, qualities, deficiencies, and the sensible accomplishment limits (estimate, response time, area, false alert, et cetera.) for the hole identification methods [9, 10].

This paper shows a composed framework for identifying leakage of (Gas or Liquid) from oil pipelines using temperature varying technique.

II. MATERIALS AND METHODS

The LMA-10 PCFS is used, with sensor of different lengths as takes after; (2, 2.5, 3) cm by Fujikura (FSM 60) mix splice machine LMA-10 PCF lengths are joined. The sensor transmission run is checked with laser diode 850 nm sources and OSA as optical range analyzer through sensor producing. The temperature variety caused wavelengths moving and sensor intensity variety.

The execution of the entire work is illuminated as take after:

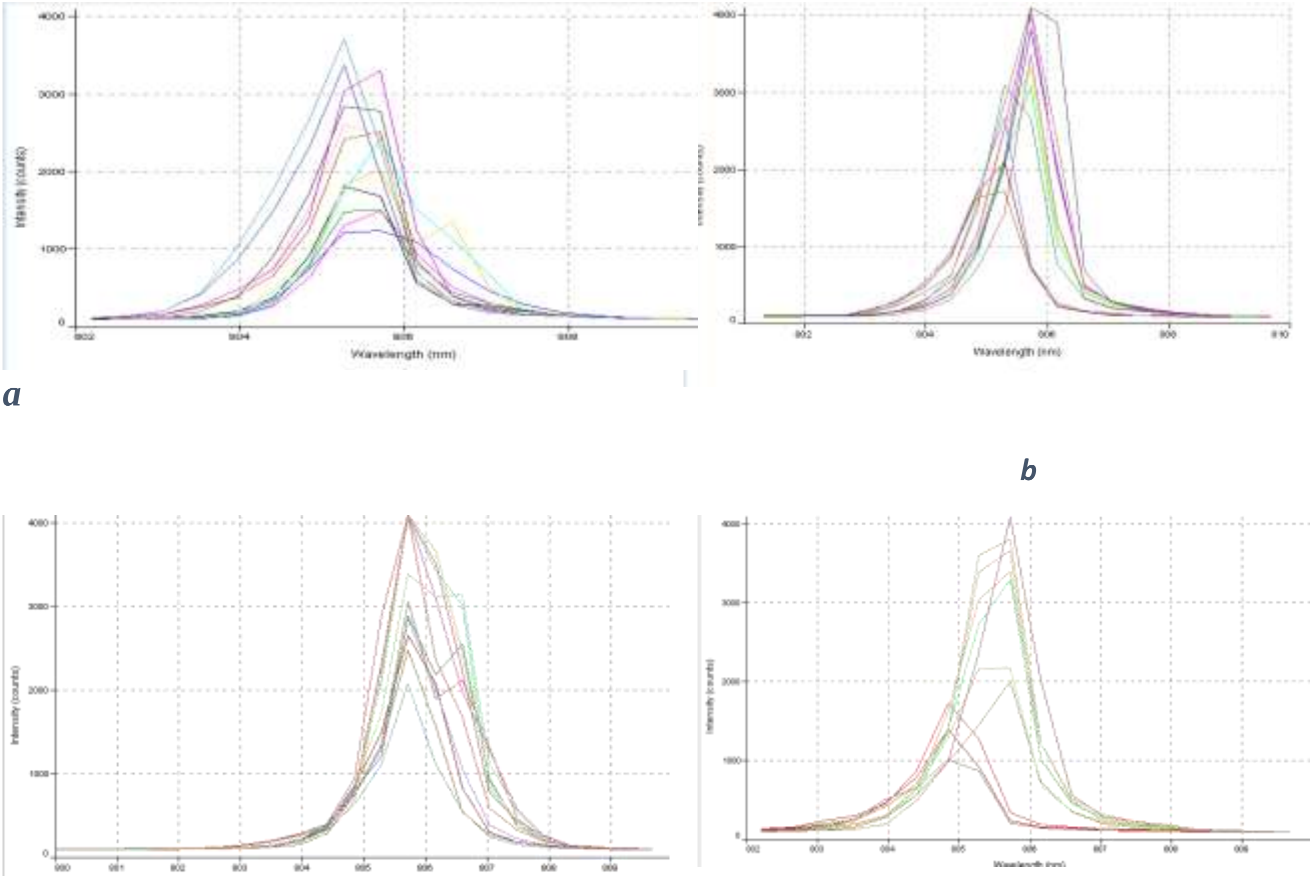
1- The PCF LMA-10 of 2 cm length for S1 and 2.5 cm length for S2 and 3 cm length for S3 are merged with SMF - 28 from both edges.
2- The two collapsed sections are physically obtainable by changing the arc duration time and power.
3- The collapsed sections length is about 300 µm.
4- The PCF sensor is shielded by a metal vessel to develop the thermal conductivity.
5- A laser diode 850nm source is utilized. The light passing through SMF to PCF, then the sensor is associated to one of the utilized pipes (polymer or steel) with dissimilar temperature, thickness and stream – rate pumping oil.
6- 4.5 mm diameter stainless steel pipe is utilized and with 30 cm length.
7- Pipe wall thickness is re framed to have dissimilar thickness, beginning with d1=7 mm and consummation with d12=1.5mm with 0.5 mm steps by utilizing a CN machine.

8- For changing the temperature from 26c to 50c, liquids water path is utilized.
9- The dissimilar sensors lengths are studied on three pipe zones (d1, d6, d12), which are associated with the pipes wall.
10- The sensor output is linked with the OSA and the spectrum output produce wavelengths shifting or intensity losses.
11- Power and intensity measurements are attained from OSA and power meter for every thickness.
12- The strain is calculated on each pipes wall thickness.

Figure 1: Steal pipeline pattern

III. RESULTS AND DISCUSSION

The guideline of temperature detecting would be credited to the obstruction between the center mode and cladding modes in single mode strands. Fig. 2 shows the transmission range for 2 cm LMA-10PCF S1 for metal pipe at various temperature from (26-50) C◦. Additionally demonstrates the impact of temperature change with the intensity, while the temperature expanding prompts force diminishing which saw from optical range analyzer.



a *b* *c* *d*

Figure 2: Transmission spectra of 2cm LMA-10 PCF interferometer for sensing leak at different temperature for metal pipe S1 a-(26), b-(36) , c-(40) ,d-(50)

Optical range analyzer OSA is used to record the obstruction spectra at various temperatures beginning from high temperature at 26°C to 50°C for 2cm LMA-10 PCF sensor OF metal pipe S1.
Interference range peaks were moved directly to long wavelength with diminishing in temperature. The enlisted impedance wavelength with temperature from 26-50°C demonstrates the red moving area, as appeared in Fig. 3.

The sensitivity of the sensor, is taken as the line slope, is assessed to be equal to (0.15) nm/RIU.

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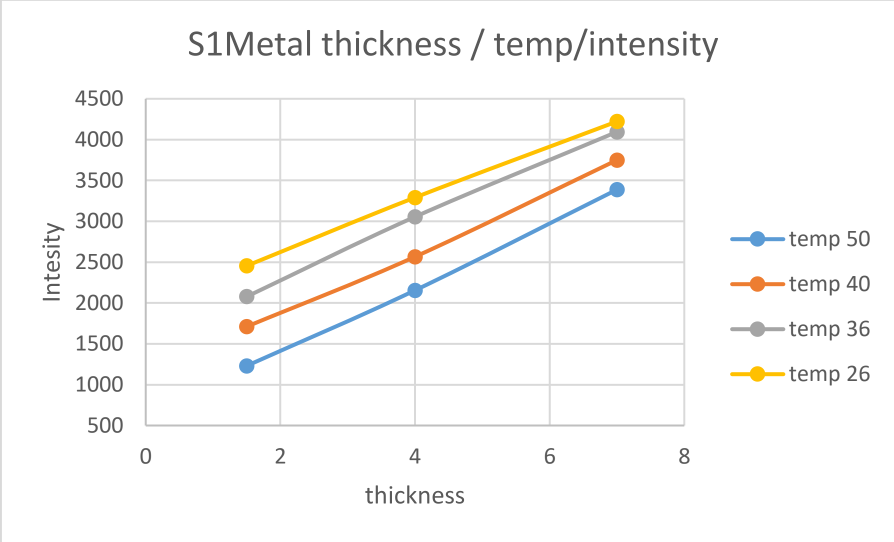
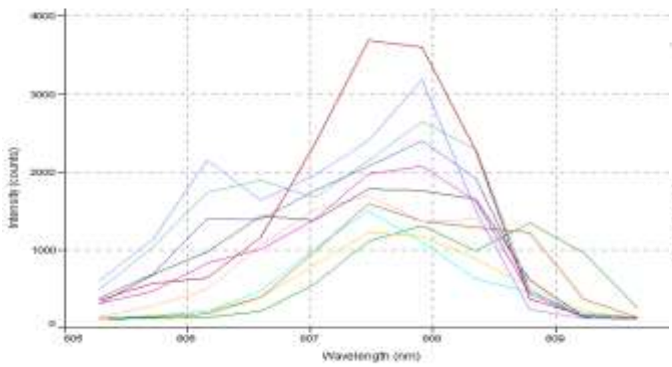


Figure 3 The relationship between intensity and (t1.t6.t12)wall thickness for different temperature of 2 cm LMA-10 PCF sensor OF metal pipe S1 (sensitivity =0.15 nm/RIU)

Figure (4) demonstrates the deliberate Transmission range for 2 cm LMA-10PCF S1 for polymer pipe at various temperature from (26-50) C◦.
Additionally demonstrates the impact of temperature change on the power, while temperature expanding prompts force diminishing, this saw from optical range analyser.



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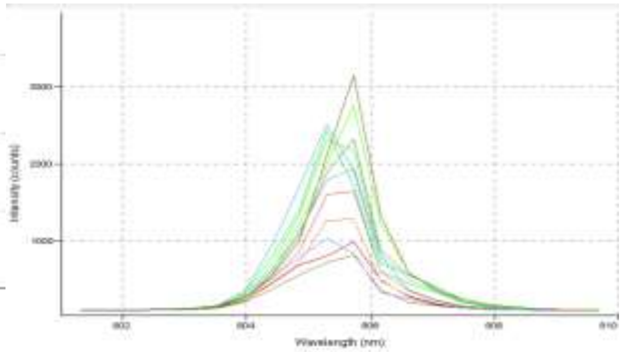

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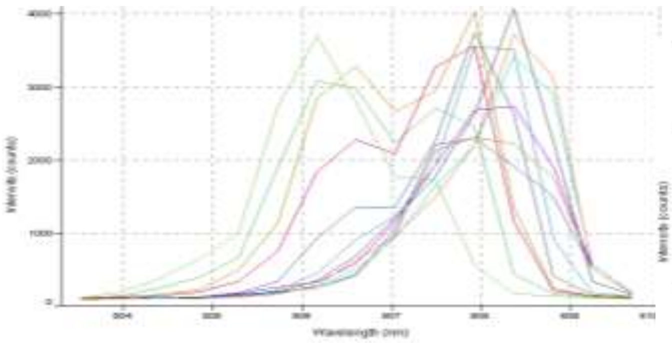

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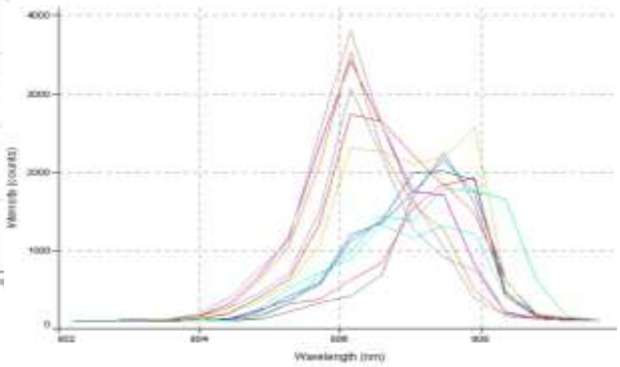

d

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Figure 4: Transmission spectra of 2cm LMA-10 PCF interferometer for sensing leak at different temperature for polymer pipe S1 a-(26), b-(36), c-(40), d-(50)

Optical range analyzer OSA is utilized to read the interference spectra at various temperatures beginning from high temperature at 26°C to 50°C for 2cm LMA-10 PCF sensor OF polymer pipe S1. The pinnacles of impedance range were moved directly to long wavelength with diminishing temperature. The enrolled obstruction wavelength with temperature from 26-350°C demonstrates the red moving district, as appeared in figure 5.
The affectability of the sensor, is characterized as the line slope, is assessed to be around (0.20) nm/RIU.

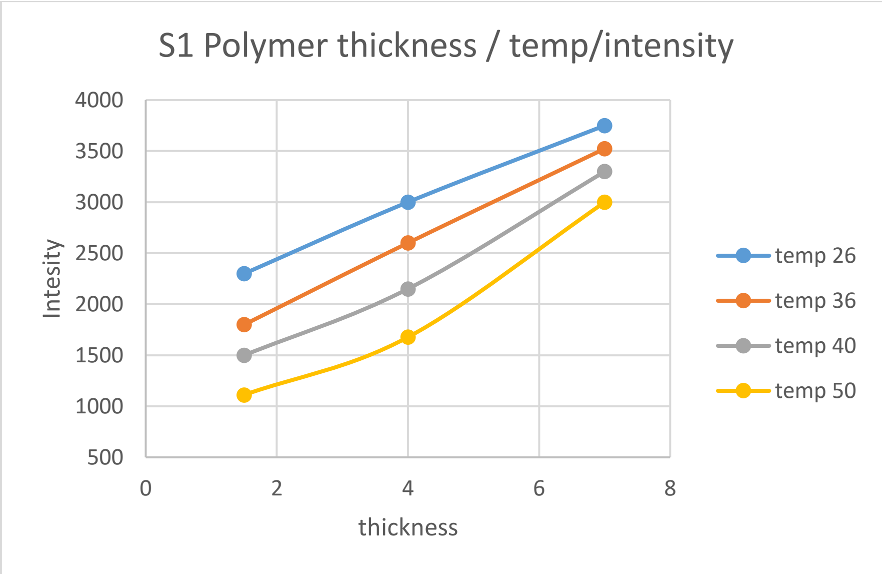
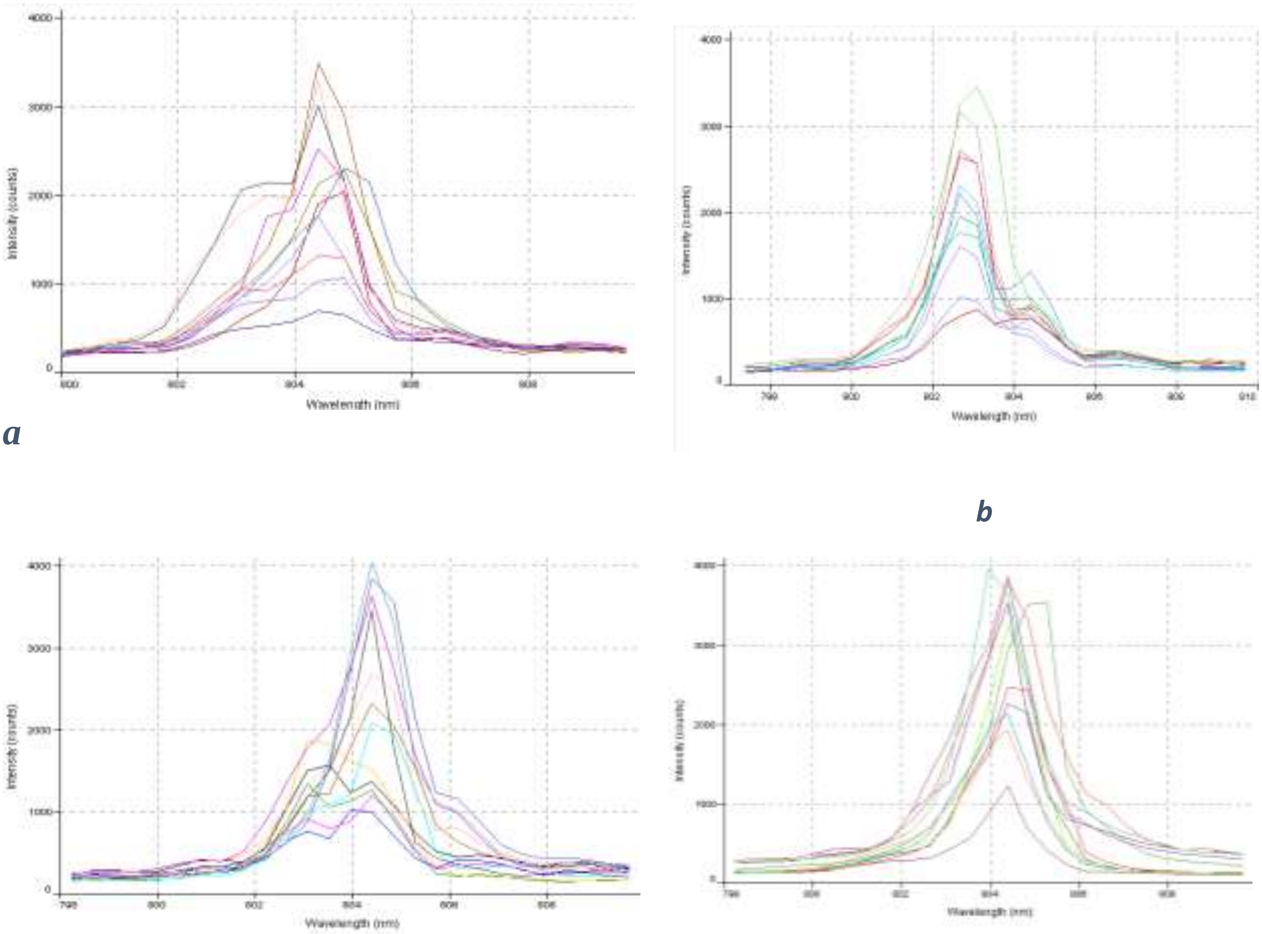


Figure 5: The relationship between intensity and (t1.t6.t12) wall thickness for different temperature of 2 cm LMA-10 PCF sensor OF polymer pipe S1 (sensitivity =0.20 nm/RIU)

Figure 6 demonstrated the Transmission range for 2.5 cm LMA-10PCF S2 for metal pipe at various temperature from (26-50) C◦ .this figure demonstrates the impact of temperature change with the intensity, though temperature increasing prompts intensity diminishing in which observed from optical spectrum analyser.



a *b* *c* *d*

Figure 6: Transmission spectra of 2.5 cm LMA-10 PCF interferometer for sensing leak at different temperature for metal pipe S2 a-(26), b-(36), c-(40), d-(50)

Optical range analyzer OSA is additionally used to read the interference spectra at various temperatures beginning from high temperature at 26°C to 50°C for 2.5 cm LMA-10 PCF sensor OF metal pipe S2. The interference range peaks were moved directly to long wavelength with diminishing temperature. The enrolled interference wavelength with temperature from 26-350°C demonstrates the red shift area, as appeared in figure 7. The affectability of the sensor, is characterized as the line slope, was assessed to be around (0.42) nm/RIU.

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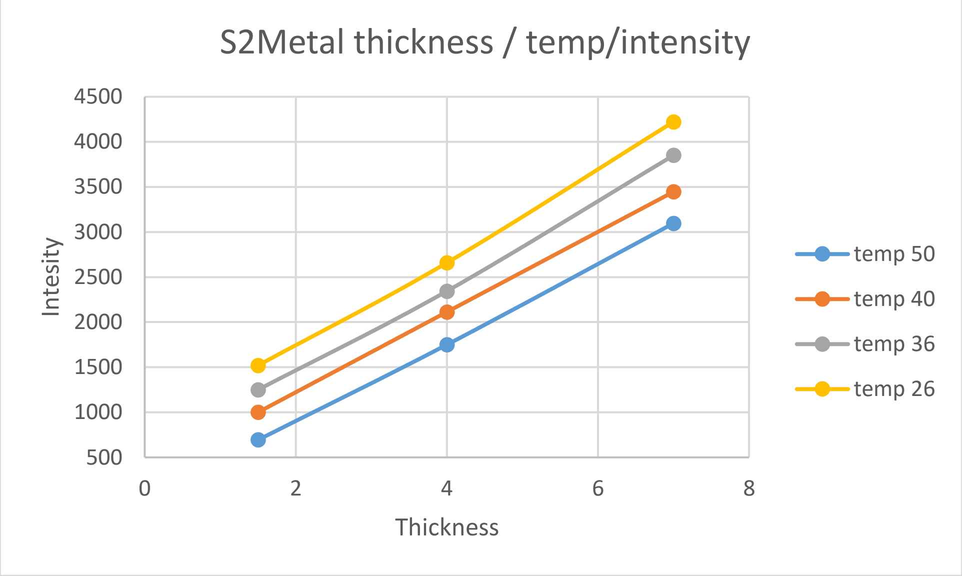

Figure 7:The relationship between intensity and (t1.t6.t12)wall thickness for different temperature of 2.5 cm LMA-10 PCF sensor of metal pipe S2 (sensitivity =0.42 nm/RIU)

Figure 8 demonstrates the deliberate transmission range for 2 .5cm LMA-10PCF S2 for polymer pipe at various temperature from (26-50) C◦. Likewise demonstrates the impact of temperature change with the force, though temperature increasing prompts diminishing in intensity which saw from optical range analyzer.

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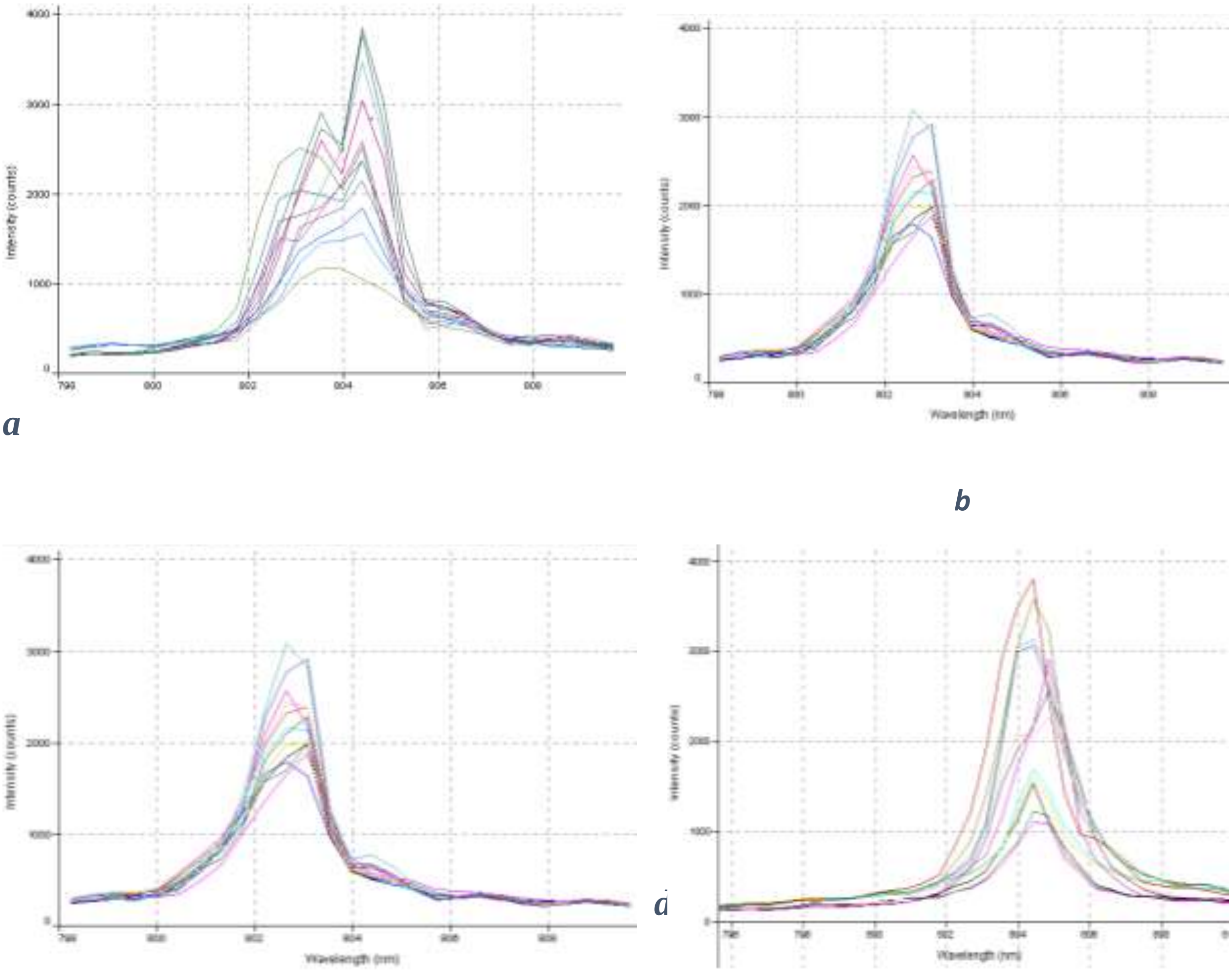

a *b* *c* *d*

Figure 8: Transmission spectra of 2.5 cm LMA-10 PCF interferometer for sensing leak at different temperature for Polymer pipe S2 a-(26), b-(36), c-(40), d-(50)

Optical range analyzer OSA was used to record the interference spectra at various temperatures beginning from high temperature at 26°C to 50°C for 2.5 cm LMA-10 PCF sensor OF polymer pipe S2. The pinnacles of interference range were moved directly to long wavelength with diminishing temperature. The enrolled interference wavelength with temperature from 26-350°C demonstrates the red shift area, as appeared in Figure 9. The affectability of the sensor, is characterized as the line slope, was assessed to be around (0.18) nm/RIU.

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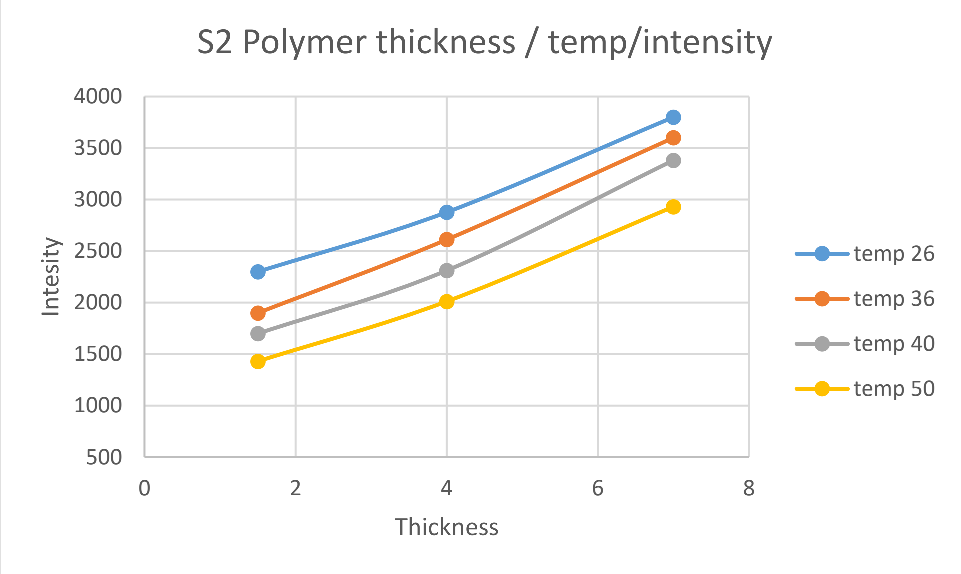

Figure 9: The relationship between intensity and (t1.t6.t12) wall thickness for different temperature of 2.5 cm LMA-10 PCF sensor of polymer pipe S2 (sensitivity =0.18 nm/RIU)

Figure 10 demonstrated the Transmission range for 3 cm LMA-10PCF S3 for metal pipe at various temperature from (26-50) C◦. Likewise demonstrates the impact of temperature change with the force, though temperature increasing prompts diminishing in intensity.

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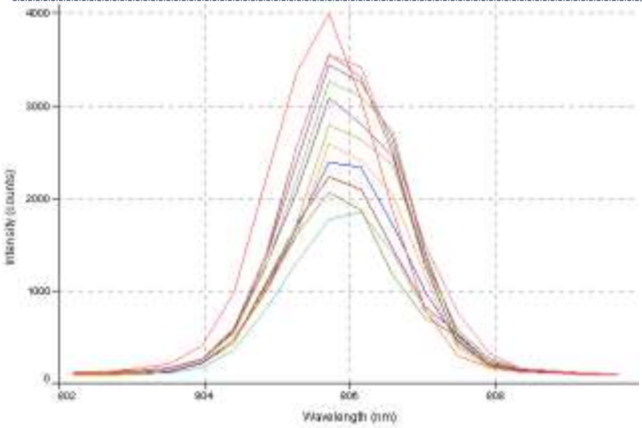
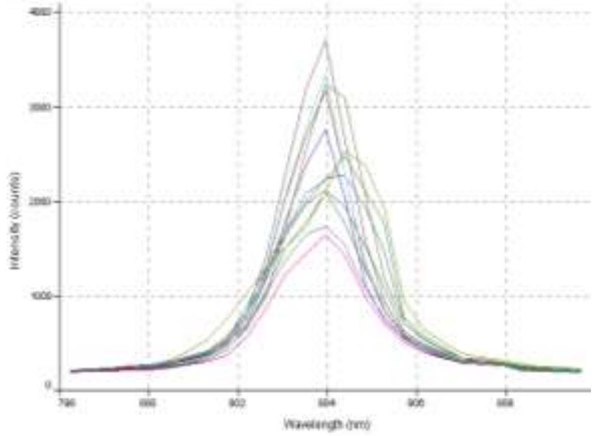


a



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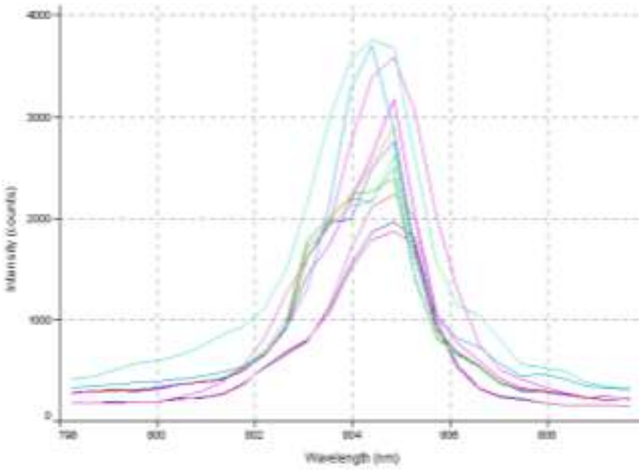

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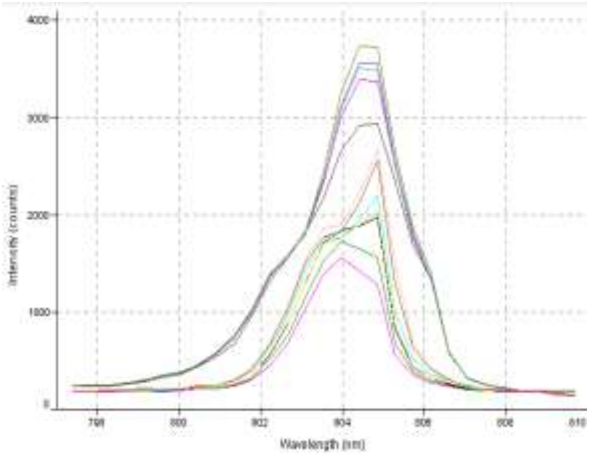

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Figure 10: Transmission spectra of 3 cm LMA-10 PCF interferometer for sensing leak at different temperature for Metal pipe S3 a-(26), b-(36), c-(40), d-(50)

Optical range analyzer OSA was utilized to record the interference spectra at various temperatures beginning from high temperature at 26°C to 50°C for 3 cm LMA-10 PCF sensor OF metal pipe S3. The interference range peaks were moved straightly to long wavelength with diminishing temperature. The enrolled interference wavelength with temperature from 26-350°C demonstrates the red shift area, as appeared in figure 11, the affectability of the sensor, is characterized as the line slope, was assessed to be around (0.25) nm/RIU

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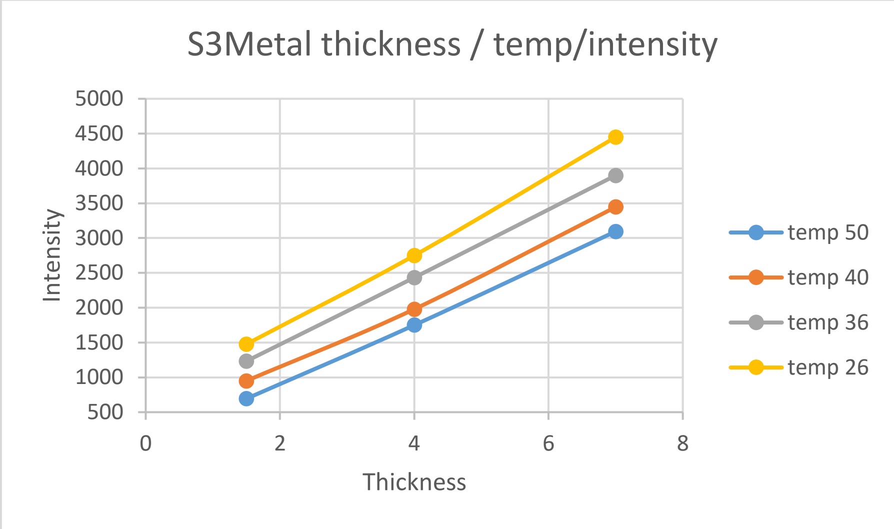
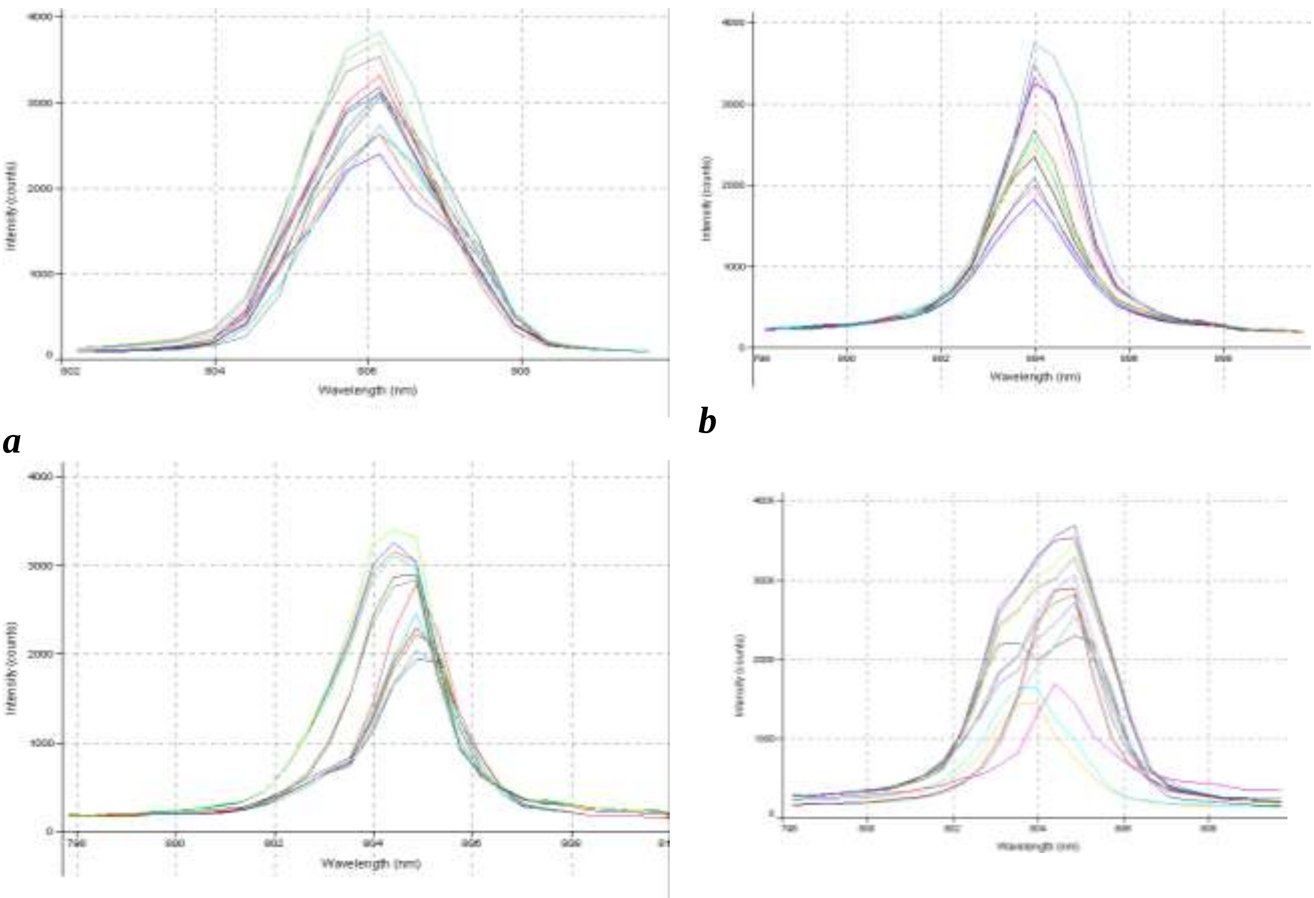


Figure 11: The relationship between intensity and (t1.t6.t12) wall thickness for different temperature of 3 cm LMA-10 PCF sensor of metal pipe S3 (sensitivity =0.25 nm/RIU)

Figure 12 demonstrated the deliberate Transmission range for 3 cm LMA-10PCF S3 for polymer pipe at various temperature from (26-50) C◦ .this figure demonstrates the impact of temperature change with the intensity, while temperature increasing prompts diminishing in intensity which saw from optical range analyzer.



a ***b*** ***c*** ***d***

Figure 12: Transmission spectra of 3 cm LMA-10 PCF interferometer for sensing leak at different temperature for polymer pipe S3. a-(26), b-(36), c-(40), d-(50)

Optical range analyzer OSA was utilized to read the interference spectra at various temperatures beginning from high temperature at 26°C to 50°C for 3 cm LMA10 PCF sensor OF polymer pipe S3. The pinnacles of interference range were moved straightly to long wavelength with diminishing temperature. The enrolled interference wavelength with temperature from 26-350°C demonstrates the red shift area, as appeared in figure 13.The affectability of the sensor, is characterized as the line slope, is assessed to be around (0.14) nm/RIU.

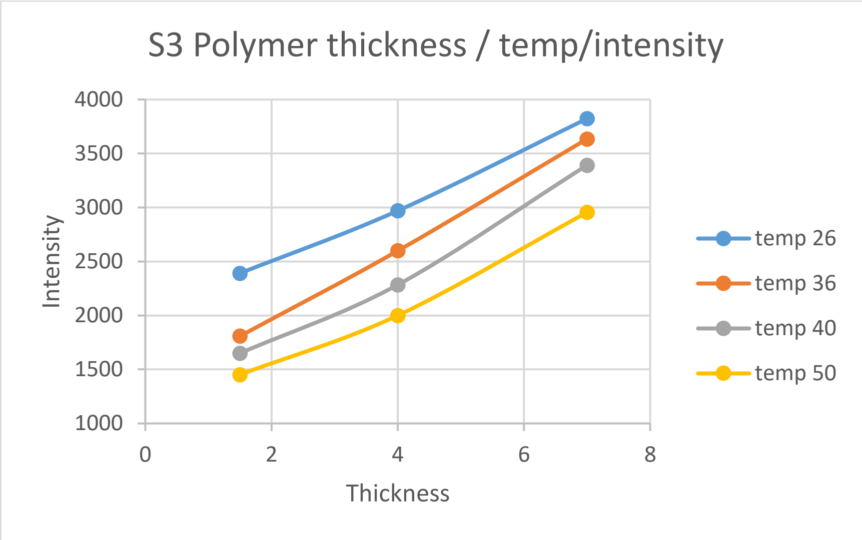


Figure 13: The relationship between intensity and (t1.t6.t12) wall thickness for different temperature of 3 cm LMA-10 PCF sensor of polymer pipe S3 (sensitivity =0.14 nm/RIU)

IV. CONCLUSION

A complete oil pipes leakage detection using various temperature techniques was presented. The results show that the temperature changing for the temperature changing technique is inversely proportional with the external intensity and the best sensitivity found for this technique is about 0.42 for metal and 0.18 for polymer.

V. REFERENCES

1. Fedor Mitschke, “fiber optics”, Rostock University, Germany, 18055, 2209.
2. Ning, Y. N., and B. T. Meggitt, “Fiber Bragg grating sensors: signal processing aspects, Optical fiber sensor technology” Springer US, pp. 381-417, 1998.
3. Fidanboylu, K. A., and H. S. Efendioglu, “Fiber optic sensors and their applications”, 5th International Advanced Technologies Symposium (IATS’09), Vol. 6, 2009.
4. Sharma, Nidhi, Neetu Rajawat, and Kavita Agrawal, “Photonic Crystal Fiber Characteristics Benefits Numerous Applications”, International Journal of Scientific and Engineering Research, 6: 28-33, 2015.
5. Schindler, Paul M., “Corrosion detection using metal coatings on fiber optic sensors”, Diss. Virginia Polytechnic Institute and State University, 1995.
6. Tennyson, Rod C., W. Don Morison, and Tom Miesner, “FOS types”, 2006.
7. Li, Mo, and Yunhao Liu,“Underground structure monitoring with wireless sensor networks”, Proceedings of the 6th international conference on Information processing in sensor networks, ACM, 2007.
8. Mishra, Ashim, and Ashwani Soni, "Leakage detection using fibre optics distributed temperature sensing", 6th Pipeline Technology Conference, 2011.
9. MANDAL, PRADIP CHANDRA, "Gas Leak Detection in Pipelines & Repairing System of Titas Gas", Journal Of Applied Engineering 2.2, 2014.
10. Sulaima, Mohamad Fani, et al., "Oil and gas offshore pipeline leak detection system: A feasibility study", 1-6, 2013.