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Application of two-output port fiber coupler as gasoline level sensor

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ABSTRACT

Detection of gasoline level can be done in a safe and simple way using two output port multimode fiber coupler with a structure of 2×2 as a sensor. Two output ports (sensing port) are connected with two reflector displacement device (RDD) and functioned as two probes. These probes are placed on the wall of gasoline tank in a storied and work interchangeably or together depending on setting of these probes. Detection mechanism of the system is based on changes in intensity of reflected light from the reflector RDD that shifts due to changes in level of gasoline (hydrostatic pressure principle). Changes in intensity of light coming into the sensing port are then forwarded to the optical detector. Experiments performed by varying the location of the second probe as 45 cm, 50 cm, and 55 cm above the first probe to detect the level of gasoline in the process of filling and emptying the tank. Experimental results show the process of filling and emptying the tank have small differences of 6% with the dynamic range, the linear region, and resolution are 100 cm, 70 cm, and 0.4 cm respectively. Sensor sensitivity in filling and emptying process of the tank are 2.7 mV/cm and 2.8 mV/cm respectively. These results were the best performance of the sensor, which occurs when the level of the second probe was 55 cm above the first probe.

1. Introduction

Detection of liquid level using optical fiber (optical fiber liquid level sensors) can be done in two methods, i.e. direct and indirect contact between the optical fiber with liquid. The second method can use other devices as a probe or utilizes change in the trajectory of light due to changes in liquid level. For the first method, direct contact between optical fiber with liquid can be made using polished plastic optical fiber [1], spiral side-emitting optical fiber [2], as well as the use of long period fiber grating [3]. All three use the principle side-emitting optical fiber. The use of a Prism as a probe that is connected with optical fiber [4], the float is connected to the cantilever which contained fiber Bragg grating [5], the lever (have buoyancy) connected with fiber interferometer [6], the system of membranes and reflectors (RDD) connected with fiber coupler [7] is an indirect contact method between fiber optic with liquid.

The types of liquid that will be detected affect the selection of fiber optics and detection method. For gasoline, safe from risk of fire and explosion during operation is a major consideration in addition to accuracy and lifetime of the sensor. A sensor with these criteria was demonstrated has been able to detect the level of gasoline using a single output port plastic fiber coupler (fiber with a structure of 2×2). One of the output ports is paired with a reflector displacement device (RDD) and serves as a probe. RDD comprises a reflector Board that is attached to the

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membrane at the bottom of the tank. The sensing principle is to detect displacement of reflector, which is attached to the membrane, due to the change of gasoline hydrostatic pressure. The displacement of reflector can be detected using fiber coupler from the change of optical power light reflected by the reflector. The results obtained are dynamic range and sensors linear region, which are 180 cm and 40 cm respectively [7]. The linear region of the sensor, a working range of the sensor, are still far from industrial needs that require the detection of gasoline or fuel level.

In this paper, efforts to increase linear region of the sensor will be described by optimizing both the output port of fiber coupler with RDD (the probe) to detect the level of gasoline in multilevel way.

2. Sensors design and operating principle

Fig. 1 shows the design of gasoline level sensor using two probes. Fig. 1(a) shows the gasoline level detection mechanism using two probes. The first probe was formed

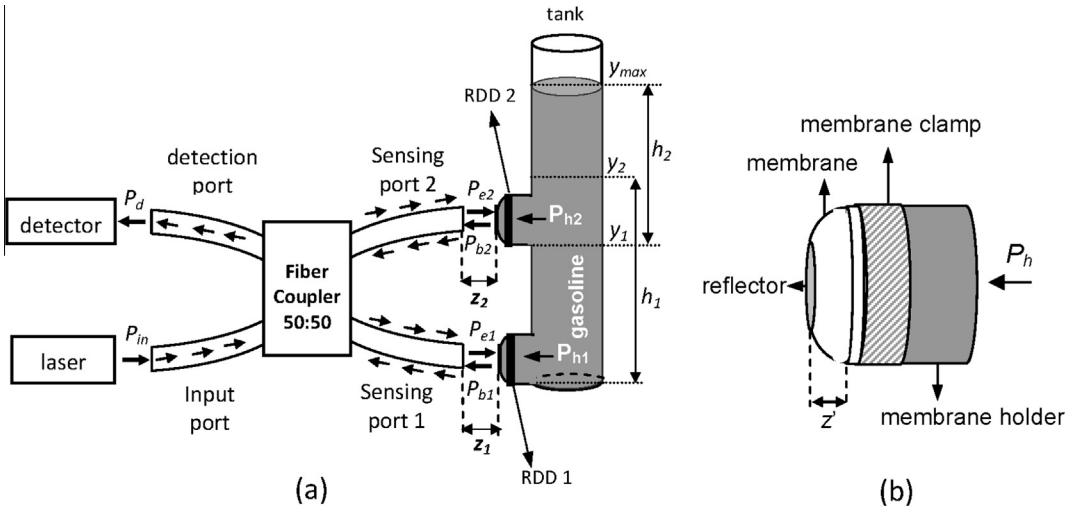

Fig. 1. (a) Sensor design and (b) reflector displacement device (RDD).

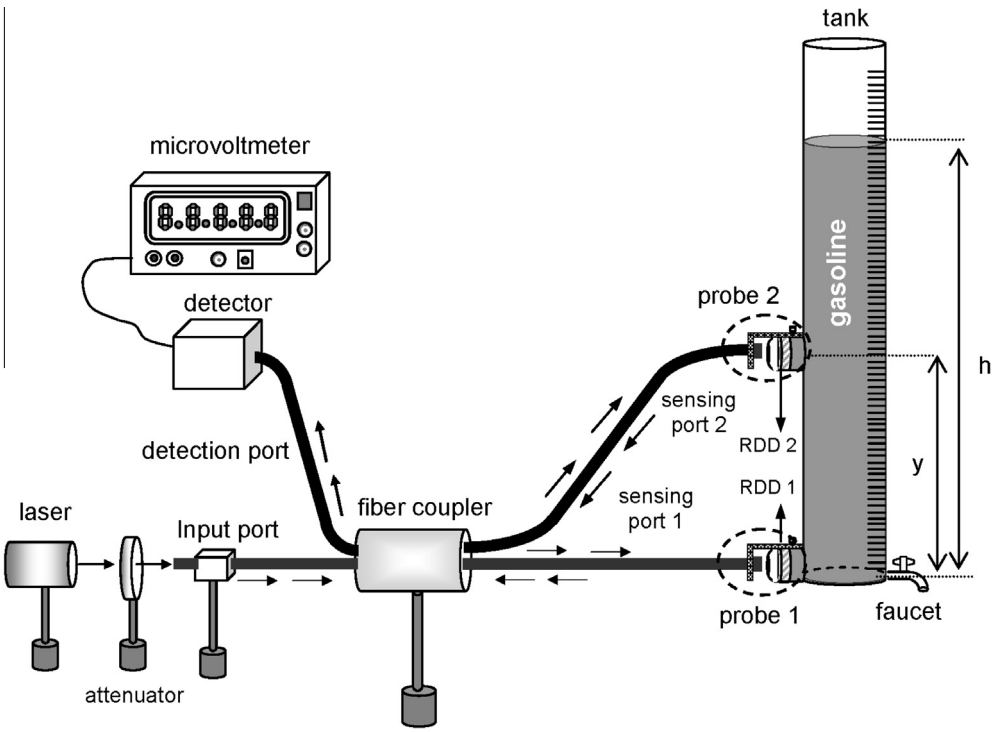

Fig. 2. Level sensor schematic diagram of gasoline using two probes.