CONCLUSION

A **multi-sensing parameter liquid detector** realized the detection of leakage liquid, assists in judging the seawater leakage rate, and realizes the intelligent identification of common leakage liquid types.

Research on Intelligent Liquid Detector Based on Fuzzy Inference

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Introduction

- In the development of offshore oil and gas resources and marine transportation, ships, mobile offshore platforms and other engineering equipment will have liquid leakage problems in various compartments.
- The current liquid detectors are used alone, and do not have the ability to distinguish the type of liquid, nor can it determine the liquid leakage rate.[1][2].
- Integrate the photoelectric liquid detection unit, temperature detection unit, medium conductivity detection unit and sea water level rise rate detection unit
- According to the conductivity and temperature characteristic data of the detected liquid, the method of fuzzy inference can be used to realize the intelligent judgment of the type of leaking liquid and detect the seawater leakage rate at the same time



Analysis of sensor mechanism

A. Photoelectric liquid level sensor

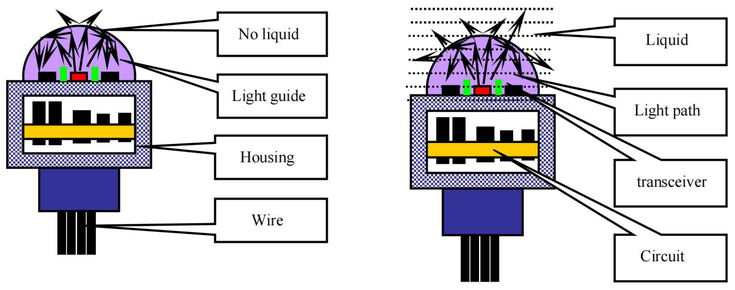


Figure 1. Schematic diagram of sensitive mechanism

B. Two electrode conductivity sensor

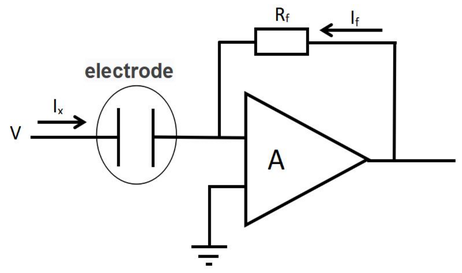
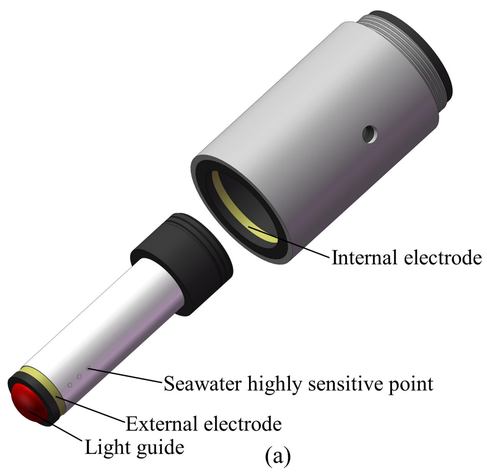


Figure 2. Schematic diagram of conductivity measuremen

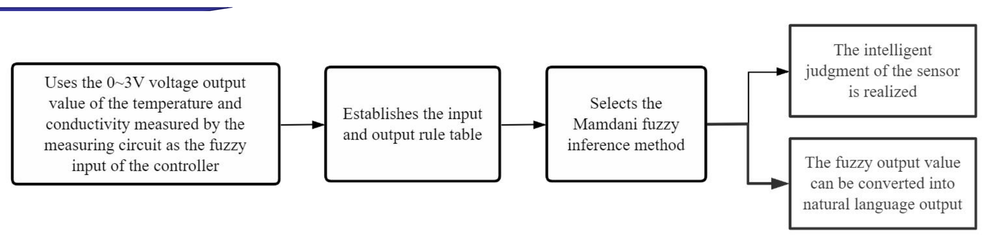
Structural design



(a)

(b)

Figure 3. (a) Exploded view of the structure of the detector along the axial direction (b) Physical image



Temperature field simulation

This article uses finite element analysis to simulate the internal temperature distribution of the diversion cover and the Pt100 temperature response。

(a) (b)

Figure 4.(a)The temperature distribution cloud diagram inside the light guide cover (b)Time response curve of platinum thermal resistance

Set the initial temperature of the light guide cover to 393.15k, the contact liquid temperature to 323.15k, and the contact time to 5s. The internal temperature of the light guide shows a two-dimensional axisymmetric distribution with the vertical z-axis as the symmetry axis. Temperature response time of platinum thermal resistance: $\tau_{50\%} = 2.8s$ $\tau_{50\%} = 2.8s$

Sensor measurement circuit design

➢ *The power supply circuit*

the sea water rises to a highly sensitive point → The sea water connects the conductivity sensor excitation electrode with the sensitive point. → The full-wave rectification current, the second-order RC filter circuit and the amplifying circuit → The sinusoidal AC voltage signal detected at the sensitive point outputs 0V and 1.8V switching signals through the voltage comparator

➢ *The output amplitude*

the sea water rises to a highly sensitive point → The sea water connects the conductivity sensor excitation electrode with the sensitive point. → The full-wave rectification current, the second-order RC filter circuit and the amplifying circuit → The sinusoidal AC voltage signal detected at the sensitive point outputs 0V and 1.8V switching signals through the voltage comparator

➢ *the liquid level rise detection circuit*

the sea water rises to a highly sensitive point → The sea water connects the conductivity sensor excitation electrode with the sensitive point. → The full-wave rectification current, the second-order RC filter circuit and the amplifying circuit → The sinusoidal AC voltage signal detected at the sensitive point outputs 0V and 1.8V switching signals through the voltage comparator

Sensor's fuzzy inference output

TABLE I. Rules of Fuzzy Reasoning

	NB	NS	Z	PS	PB
NB	OT	OT	SW	SW	SW
NS	OT	CL	CL	SW	SW
Z	CL	CL	CL	SW	SW
PS	CL	CL	CL	SW	SW
PB	CL	CL	CL	CL	SW

Temperature: T={NB,NS,Z,PS,PB}
Conductivity: C={NB,NS,Z,PS,PB}
Liquid type: S={TO,CL,SW}

NB: very low; NS: low; Z: moderate; PS: high; PB: very high;

TO: fuel oil; CL: coolant; SW: sea water;

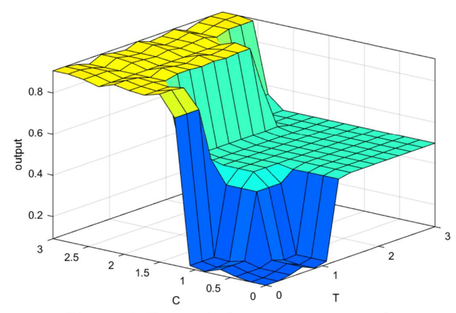


Figure 5. Fuzzy inference output surface

Blue OT, green CL, yellow SW, effectively distinguish three kinds of liquids: sea water, fuel oil and coolant

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