Network Wireless Sensor for Remote Monitoring of Gas Wells

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1. Introduction

A rapid increase in the global demand for natural gas is being watched with keen interest due to the resource issue and international politics feud etc., and meanwhile, it advances the infrastructure equipment relating to the production and transportation and gives a considerable impact on the industrial world as well. It is prospective that such circumstances will be prolonged, and the huge investment to the downstream sectors such as LNG chains is intensifying the world's engineering companies and measurement manufacturers' activities. However, if the upstream sectors also pay attention to natural gas production sites, it has to say that the technical ability and total amount of investment input are relatively limited, and there are still many gas wells either ① no any measurement, or ② depending on mechanical type (disk) recorders and human-wave tactics, existing. Only a few gas wells ③ having a large production output are being monitored intensively with the traditional SCADA (supervisory control and data acquisition) system. It is said that the average downtime of gas wells around the world is 10%, and the improvement of production efficiency has become an important issue. With utilizing the sensor technology to monitor gas wells, Fuji Electric is aiming to improve production efficiency.

Canada, ranked 18th in terms of natural gas reserves, has become the most advanced country of remote monitoring, because it has been sensitive to the issue of resource saving and pursuing production efficiency from the earlier date. Fuji Electric has cooperated with a Canadian venture company to develop state-of-the-art devices for remote monitoring since it was aware of the tendency of the market 4 years ago. The partner, Zed.i Solutions Inc., regards ① the networking technology that enables to monitor gas and oil over an extremely wide area under N:N, ② providing unlimited expandability and high security to the transmitting and receiving sides, ③ a seamless line without an intermediate system (such as SCADA host computer) become more briefly, and ④ the real explosion-proof wireless field device which is the only one of its kind in the world using the world's No. 1 low power-consumption sensor, as differentiating factors, and supplies business tools that are directly connected with operation, finance and management program for natural gas fields.

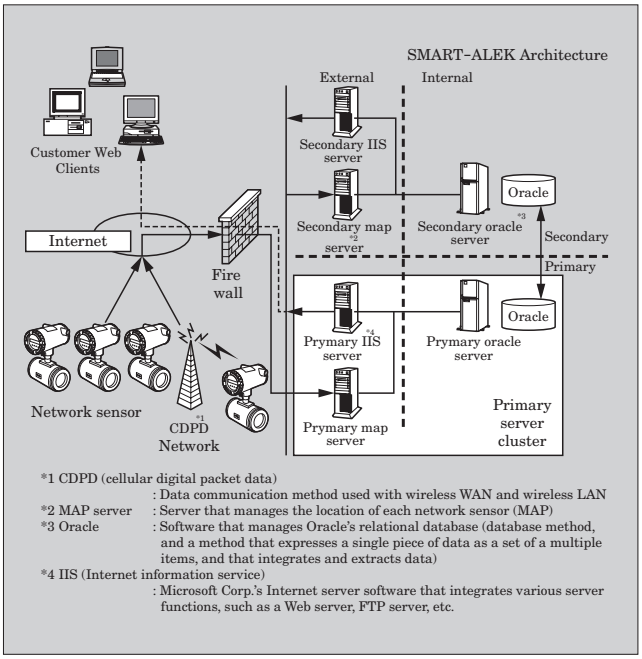
∗1: LNG chain: The sequence, including production and transportation, from the gas field to the user. (LNG: liquefied natural gas)

2. Outline of Network Wireless Sensor for Remote Monitoring of Gas Wells

2.1 Gas wells remote monitoring system

The network sensor for gas wells monitoring is a wireless field device equipped with an intelligent function for measuring the gas well flow rate. This wireless network sensor (WNS) was designed as an exclusive terminal for Zed.i Solutions' gas well monitoring systems. The sensor has its own networking terminal and IP (Internet protocol) address, and operates automatically to retain data even if communication being inter-

Fig.1 Configuration of a gas well remote monitoring system



rupted. The network sensor forming the basis of the gas well monitoring system has a main function that is to convert the physical parameters of pressure and temperature of each well into digital information. Gas well information is stored in the network sensor, and then transmitted via public wireless or satellite-based communications to a network server. The gas well monitoring system enables end users to monitor, measure and analyze the performance of their gas wells and pipelines in real time via an end user interface. In addition, the monitoring system can be configured to send alarms remotely so that an operator can quickly ascertain and respond to problems when an alarm occurs. Because the gas well monitoring system is web-based, data can be accessed and utilized by the end user at any time.

Figure 1 shows the configuration of a gas well remote monitoring system.

In a gas well monitoring system, field devices communicate with a network server via a public wireless network or satellite-based communications and the Internet, and the end user is connected to the network. The gas well monitoring system implements the following basic functions.

(1) Measurement of gas well pressure, flow rate and temperature
(2) Transfer of data from the network sensor to the main network database
(3) Provision of raw data and computed information to the end user via the Internet

Figure 2 shows the user interface and Fig. 3 shows the historical trends of gas well monitoring systems.

Monitoring points that are equipped with a network sensor indicate not only the flow rate at the time of measurement, but can also show instantaneously the historical trends, alarms, recovery history, and the like, and can be used to ascertain the amount of remaining well reserves, lifespan, and so on.

For network sensors, Fuji Electric has been supplying the FCX-A II series of high-precision pressure sensor units and the associated interface unit to Zed.i Solutions.

Fig.2 Web user interface

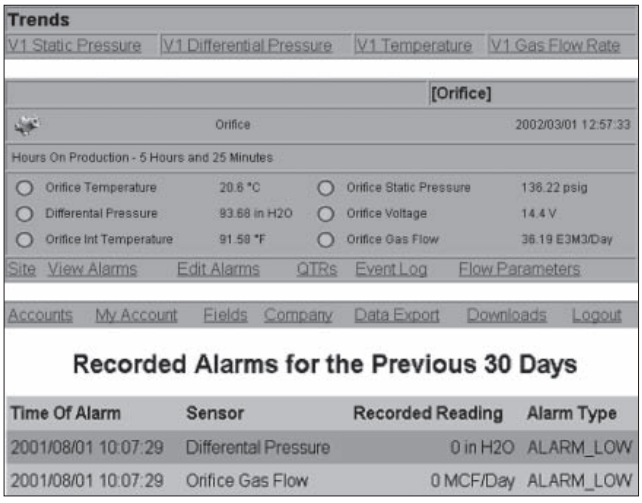
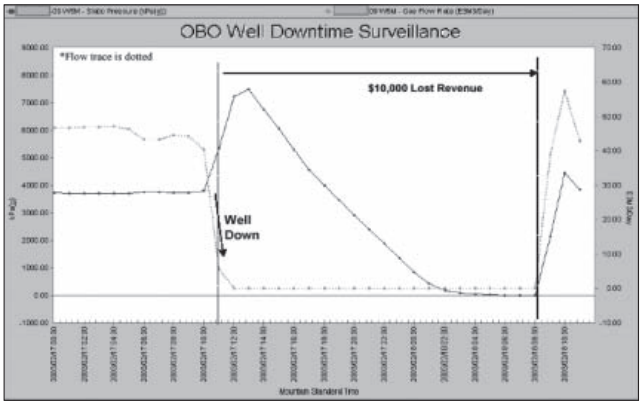


Fig.3 Historical trends of gas well remote monitoring systems



2.2 V2X network sensor

The Version 2.0X (V2X) gas well monitoring system network sensor, newly developed in collaboration with Zed.i Solutions, inherits all the functionality of the previous Version 2.0 sensor, and an additional feature is the modification of the explosion-proof construction, that is, the previous pressure-resistant explosion-proof structure has been changed to an intrinsically-safe explosion-proof structure, and is made to be lighter in weight and low price, in support of the price likely-to-intensify competition among monitoring systems in the field of natural gas production. Just like Version 2.0 sensor measures the pressure, flow rate and temperature of a gas well or pipeline, stores the measured values, and then transmits those values reliably via a public wireless communications network to a network server. Since the V2X is used in hazardous locations where there is the risk of explosion, Canada's explosion-proof certification has been acquired. At present, the V2X is the world's only wireless field device rated at class 1 and division 1 explosion protection, which is

Fig.4 External view of V2X network sensor

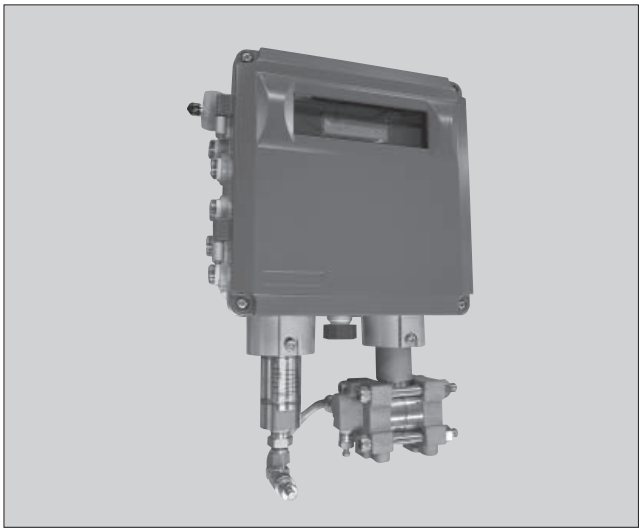


Table 1 V2X specifications

Service	Measurement of gas and oil flow rate		
Measurement range	Type	Pressure range	Differential pressure range
	FZA022	0 to 500 kPa	0 to 6 kPa
	FZA032	0 to 3 MPa	0 to 6 kPa
	FZA023	0 to 500 kPa	0 to 32 kPa
	FZA043	0 to 10 MPa	0 to 32 kPa
	FZA053	0 to 17.24 MPa	0 to 32 kPa
	FZA045	0 to 10 MPa	0 to 130 kPa
	FZA055	0 to 17.24 MPa	0 to 130 kPa
Materials	Diaphragm : 316L stainless steel Process cover : 316 stainless steel Bolts and nuts for process cover : Carbon steel Fill fluid : Silicone oil O-ring : Viton		
Mounting method	Pipe mounting (using bracket)		
Output signal	Public wireless (CDMA) or RS-232C for satellite-based transmission		
External I/O signals	Resistance temperature detector (4-line type) RS-485 (well head pressure gauge, turbine meter, etc.) Status input : Contact (2 contacts) Pulse input : Open collector (1 contact) Contact output : 1 contact		
Power source	Solar panel and rechargeable battery (capable of transmission up to 7 days without solar panel power input)		
Power consumption	3 W or less (during transmission)		
Intrinsic safety	CSA intrinsic safety Class 1 Div 1 Group C, D T3 (–40 to +60°C)		
Enclosure type	JIS C 0920 spray-proof type IEC IP56		
Mass	Approx. 12 kg		
Operating temperature	–40 to +60°C (main unit) LCD display : –20 to +60°C Modem : –20 to +60°C		
Humidity limit	95 % RH or less		

Table 2 V2X performance

Accuracy	±0.1 % URL : Differential pressure sensor and gauge pressure sensor ±0.25°C/25°C (room temperature) : Resistance temperature detector (RTD) input (4-line type)
Supply voltage effect	±0.1 % URL : DP sensor, GP sensor ±0.25°C : RTD (battery voltage 6 to 8 V DC)
Current consumption	2 mA or lower (during standby) 500 mA or lower (when active)
Radiated EMI	FCC part15, ClassA

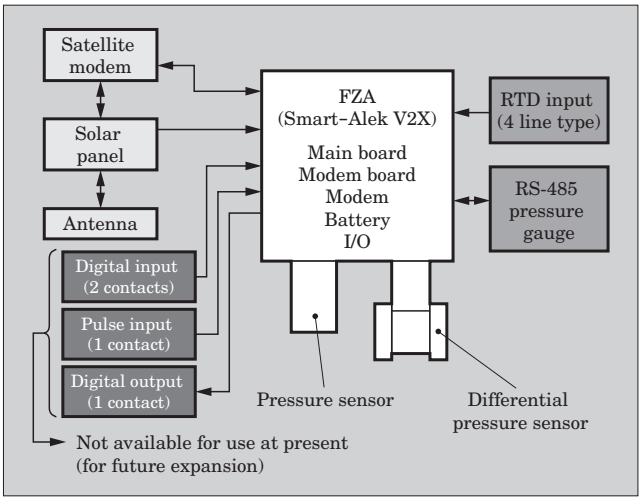
the highest level of explosion protection, and having intrinsically-safe explosion protection. Figure 4 shows the external appearance of the V2X network sensor for gas well monitoring systems.

The V2X network sensor operates with a rechargeable battery and a solar panel. Peripheral devices include the solar panel, an antenna and a resistance temperature detector (RTD). A characteristic of field devices is that they can be installed or replaced by one

Table 3 V2X functions

Wireless communication	CDMA : Data rate : 115.2 kbps RF power : 300 mW (typ.) Frequency : 824 to 893 MHz (cell phone) Operating temperature : –20 to +60°C Satellite : Data rate : 19,200 bps (RS-232, modem is installed separately)
Diagnostic function	Low battery voltage, internal temperature, sensor failure
Setting function	Re-range, LCD display (external switch), calibration
Data collection	Data collection for up to 35 days

Fig.5 V2X functional block diagram



person in a short time, and can be set up and adjusted (configured) with a laptop computer. For implementing a low power operation, the network sensor itself controls a scheduling function that activates the network sensor communications link. When a user initiates remote communication with a network sensor, the network sensor is accessed in synchronization with a predetermined data transfer interval. The data transfer interval is determined and set according to the sampling requirements and the type of communications (public wireless network or satellite-based communications).

The sampling interval for measurement can be set to various values if it is not less than one second. The main specifications, performance and functions of the V2X are listed in Tables 1, 2 and 3, respectively.

Figure 5 shows a functional block diagram of the V2X.

The V2X is configured from a main unit, a solar panel, an antenna and an RTD input. The main unit consists of a main board that implements the processing measurement, communications and control, a modem board for the modem interface, a modem for use with public wireless networks, a rechargeable battery, and differential pressure and pressure sensors. Also, in case of satellite-based communications, an external

modem unit is provided instead of the main unit's internal modem. Digital I/O and pulse input are also provided for future expansion. The network sensor is a unique as a field device, and may be a WNS that is capable of measuring the gas well flow rate or an RTU (remote terminal unit) that transmits the collective measured values from several types of sensors (such as a well head pressure and turbine meter) that are connected simultaneously.

3. Conclusion

An overview of the latest network sensor technology for using in remote monitoring of gas wells has been presented.

Fuji Electric's mission is to provide excellent technology (unlimited expandability to the transmitting and receiving sides, seamless performance that eliminates the need for an intermediate system), highly reliable sensor technology (the world's leading low power consumption sensor), and field devices (world's only intrinsically-safe wireless field device), to contribute to the efficient utilization of energy, and to improve production efficiency.