Research of Diaper Diffusion Measuring System by Needle Array Method

You-Horng Lin, Ke-Nung Huang, I-Cheng Shen, I-Hsing Huang, and Ching-Hsing Luo

***Abstract*—The major vertical components of diaper are non-woven layer, diffusion layer and low density polyethylene (LDPE). The water diffusion rate of diffusion layer is the fastest layer. Several studies have shown that there is no suitable method about measuring the water diffusion conditions inside the diaper. Therefore, this study proposes a needle array method (NAM) to measure the moisture diffusion conditions at the diffusion layer which is the fastest diffused layer inside the diaper. The instrument shows the diffusion condition immediately to the LCM and stores the data on PC.**

***Index Terms*—diaper, diffusion, needle array method, NAM**

I. Introduction

Diapers need good water absorption characteristics, so that users can maintain optimal freshness. The water absorption characteristics depends on the water whether it can be absorbed large and evenly by absorbent material. The composition of the diaper is Super-absorbent Polymer (SAP) that can absorb water large and evenly as the main material. SAP is an polymer that can absorb hundreds of times or even several thousand times its own weight of water, and can maintain the absorbent flow state and expansion. To avoid the local area of the absorbent material saturated, diaper must have good diffusion characteristics, so that water can be evenly absorbed by other regions of the absorbent material. The major vertical components of diaper are non-woven layer, diffusion layer and low density polyethylene (LDPE). The water diffusion rate of diffusion layer is the fastest. We must investigate the diffusion status of the diffusion layer as the main target in order to understand diaper's absorption and diffusion of moisture condition. There are methods of measuring water diffusion range such as chemicals measurement method [1], image measurement method [2], impedance measurement method [3], [4], [5], capacitive sensor measurement method [6], and radiation contrast measurement method [2], [7]. The chemicals measurement method [1] have to be interpreted manually that will increase the measurement error. The image measurement method and the impedance measurement method [3], [4], [5] can only be used for the surface moisture range detection. The capacitive sensor measurement method [6] have larger volume that can not be applied on the diaper. The radiation contrast measurement method [2], [7] can detect the multi-layer moisture diffusion conditions, but large, expensive laboratory equipment and radiation safety problem. Compared with other literature, this study proposes the measuring instruments by NAM has the advantages of measuring the moisture diffusion condition at the diffusion layer which is the fastest diffused layer inside the diaper. The NAM of this study is to place the diaper on the needle array platform, the measurement equipment will measure and record the data that will be analyzed to moisture diffusion condition after the designed experimental procedures.

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II. System Implement

This study implement the NAM by the hardware and software design. Fig. 1 illustrated the diagram of the NAM diaper diffusion measuring system. We design a set of measurement instrument with micro-controller as the main control center.

A. Actual Diagram

We design a 60-pins platform and each pin is 3cm apart. Each pin is connected to the bus with transmission line. The water is injected to the center of the platform from the funnel by the controlled relay. A short-circuit detection circuit is designed in the front end of the funnel hole to record the spill time.

B. Main Measurement Instrument

The P89C238 micro-controller is used as the main control center for the main measurement instrument.

C. Data Transmission

The measured Data transmission based on parallel-in-serial-out method. The real time design make the data immediately rendered on the PC screen and save the data on the PC.

III. Method

The proposed NAM of this study using the designed needle array platform is to measure the artificial urine diffusion condition at the diffusion layer inside the diaper. Placing the testing diaper on the 60-pins needle array platform, the probing needles puncture through the testing diaper. When the automatic measuring instrument starts operation, the controlled artificial urine volume injected to the center of the diaper and the start time is recorded. The artificial urine diffusion starts in the diaper with the injection of artificial urine. As time go by, the probing needles generates trigger signal when the artificial urine touches the probe. The main measurement instrument receives the signals through the bus collected of 60-pins trigger signals and analyzed as the diffusion time T01-T60 by the potential decoder circuit. Then the instrument shows the diffusion condition immediately to the LCM and stores the data on PC.

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IV. Experiment Process

The needle array method (NAM) is used to measure the moisture diffusion conditions at the diffusion layer which is the fastest diffused layer inside the diaper. The following steps describe the process of the experimental procedures.

A. Placing the tested subject

Placing the diaper flat on the 60-pins platform.

B. Instrument Setting

Set the subject number, case number, subject weight, the number of experiments and the other parameters. Set the motor parameter of inject flow time, the injected amount, time interval, and the times of injecting water. Press the start button, the instrument start the total measurement automatically.

C. Measuring

Fix the artificial urine flow by controlled relay's time. Inject the concentration of 0.9 % of the artificial urine with fixing the artificial urine flow by controlled relay's time. When the artificial urine diffuse to the needle, the potential difference changes and generates a trigger signal. The trigger signal will be calculated as the diffusion time by potential detection circuit. Combination of 60-pins signals can be analyzed as moisture diffusion condition by the instrument automatically.

D. Data and Diffusion Chart

The 60-pins signals are analyzed by potential decoder circuit as diffusion time and shown in Fig. 2. Figure 3 shows the diffusion chart of the experimental results. The data is analyzed as the diffusion chart and thus is shown on LCM immediately.

V. Conclusion

In this study, the use of self-designed measuring instrument can measure and record the data that will be analyzed to moisture diffusion condition at the diffusion layer which is the fastest diffused layer inside the diaper by NAM automatically. Compared with other literature, this study proposes the measuring instruments by NAM has the advantages of measuring the moisture diffusion condition at the diffusion layer which is the fastest diffused layer inside the diaper, operating environment security with no radiation danger, easy to repeat the measurement, automatically measure to reduce human operation error.

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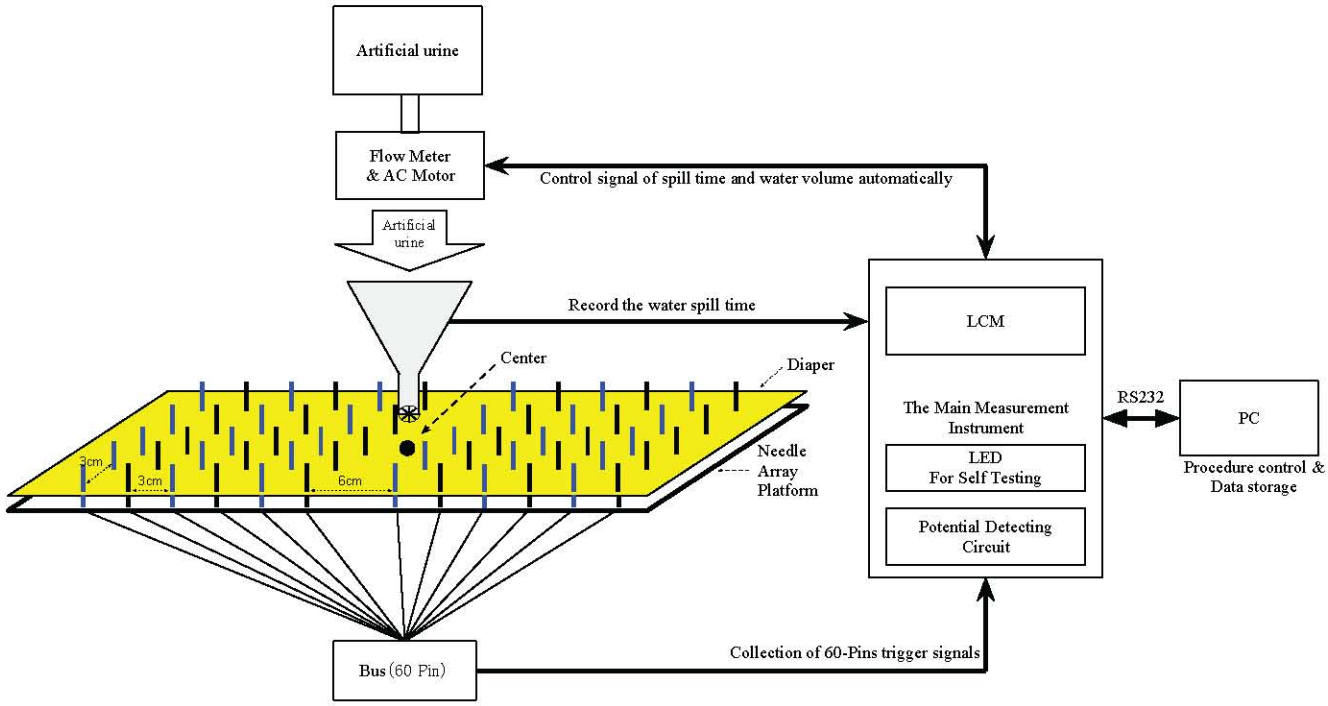

Fig. 1. Total Diagram of Diffusion Chart

Testing Subject	Back Part							Front Part						
	18 cm	15 cm	12 cm	9 cm	6 cm	3 cm	0 cm	3 cm	6 cm	9 cm	12 cm	15 cm	18 cm	cm
Average			1157.4	787.3	468.6	333.3		267.7	420.1	1188.2				6 cm
			1250.9	643.7	272.2	5.5		4.5	235.6	1074.8	1253.6			3 cm
			1304.9	732.9	311.1	2.8	center	2.8	99.6	1169.2				0 cm
				1067.3	449.8	8.8		5.7	741.1					3 cm
						635.7		364.3	1103.2					6 cm

Fig. 2. Diffusion Test (Position: Flat, Pressure: $27.8g/cm^2$, Injected articial urine volume: $30g*5times = 150g$, time interval: $5min$, injected position: center, wet pin numbers: 30)

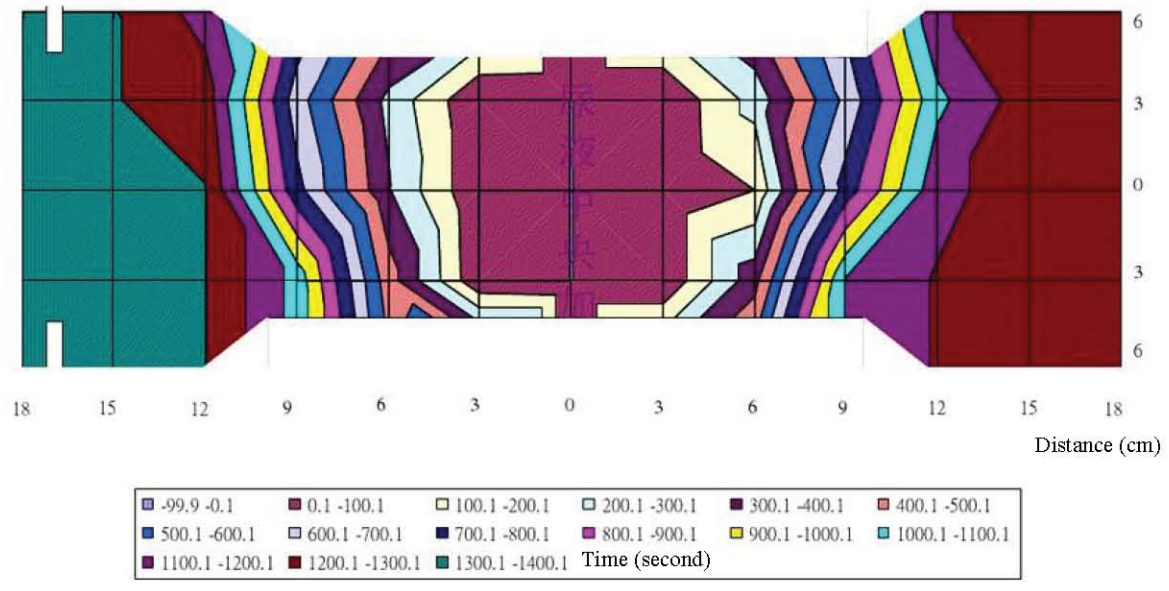

Fig. 3. Diffusion Chart

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