## Location: Ruminants Feeding Standard Research and Development Center, Khon Kaen, THAILAND

## Bureau of Animal Nutrition Development, Department of Livestock Development, DLD

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**Description of facility:**

DLD's headbox facility comprise

- Feed bunk adequate to feed and record intake of 16 cattle individually.
- Four (4) chambers with associated metabolic crates for collection of faeces and urine.
- The air flow system, gas analyzers and computer are in the control room.

**Principle of operation:**

*Summary:* The principle of operation for Ventilated hood-type respiration calorimeters is based on an open circuit system and real-time data recording. Gas emission was measured by the head-hood system installed for 3 days each cow each period. A constant airflow from the animal chamber into the measurement system was controlled by blowers (Air suction pump) installed at the end of the system which the flow meter used to measure the air flow rate through the main tube. Then a small pump draws a sample of this air and directs it into each gas analyzers: Oxygen analyzer, Carbon dioxide analyzer and Methane analyzer. The values measured by the air flow meter and the gas analyzers are analog electrical signals then sent to a receiver and signal converter (A/D converter), which transforms them into digital values. Finally, these digital values are transmitted to a computer and stored using specialized software. (Open-circuit system with ventilated hood-type respiration calorimeters with details of the system structure according to the report of Suzuki et al., 2007, Suzuki et al., 2008). (Fig.1) System details re as below:

*Headbox details:* 80 x 105 x 173 cm box, raised 7.5 cm off the metabolic crates that raised 33 cm off the ground. (Fig.2, 3) The front of the cage has a square box made of stainless steel and has a clear acrylic sheet. It is a component that allows the view inside the box to help reduce stress for the animals. The animals are held in place by a cloth around their necks to hold the front of the animals inside the enclosure, which is similar to a hood. (Fig.4) Inside the enclosure are feed bunk and an automatic water bowl. (Fig.5) The back of the cage is an open area where the animals can stand or lie down normally.

*Air flow:* Ambient air flows through the hood into the chamber in one direction only, with no backflow that is controlled by a blower (Air suction pump) installed at the end of the system. (Fig.6). The vortex blower dawns air from each animal chamber, through the upper air pipe into the main tube, then blow out through the other port of the blower. There's the flow meter used to measure the air flow rate through the main tube that can range from 100 to 700 liters per minute. (Fig.7) The display on the flow rate meter is recorded at the start and end of the 23h 30m measurement period and divided by time elapsed to calculate flow rate.

*Air Temperature and Pressure:* The air flow meter is a thermal flow cell type with temperature compensation and is suitable for measuring very low flow rates such as cow breath to minimize these effects and ensure accurate readings under varying.

*Air Sampling:* A continuous air sampling for 23h 30m after closing the door. Once the air enters the main tube, a small pump draws the air sample through the auto gas sampling unit (Fig.8a, 8b), sends to the gas cooling dryer (Fig.9), then through the needle valve flow meters (Fig.10) into each gas analyzers including the Oxygen analyzer, Carbon dioxide analyzer and Methane analyzer. (Fig.11) Each gas analyzer has its own dedicated pump.

*Gas analysis:* The concentrations of $O_2$, $CO_2$ and $CH_4$ from respiration were measured continuously by each gas analyzer. Oxygen analyzer is paramagnetic system but carbon dioxide and methane analyzer are a non-dispersive infrared sensor (VA-5000 series, Horiba, Japan; IR-200, Yokogawa Electric, Tokyo). The values measured are analog electrical signals then sent to a receiver and signal converter (A/D converter), which transforms them into digital values. Finally, these digital values are transmitted to a computer and stored using specialized software. This system records data in real time, continuously recording over 23 hours per day for 3 days per cow. Therefore, before starting the operation, the gas analyzer must be calibrated every morning before closing the chamber. There are the following methods:

- Warm up the entire system for at least 1 hour. Turn on the computer to open the dedicated software (GASMET, developed by Dr.Tomoyuki Suzuki) for recording data, such as the volume of oxygen gas, carbon dioxide gas, methane gas, and the air flow rate. (Do it only on the first day of each period)
- Before closing the chamber every morning, calibrate the three (3) gas analyzers: Oxygen analyzer, Carbon dioxide analyzer, and Methane analyzer. Use standard gases specific to each gas type at the highest level (Span gas) and the lowest level (Zero gas). These values must be accurate according to the standard certificate attached to each gas cylinder.

**Gas recovery procedure:**

Before the operation, the whole system check must be performed with pure carbon dioxide gas ($CO_2$, 99.99% purity) to check for gas leakage in the whole system. The recovery check value must be in the range of 95-105 % (Suzuki et al., 2008). After power on the GASMET program in computer and already calibrate the gas analyzers. Then, close the test chamber door, activate the blower adjusting the airflow for the anticipated animal size. Introduce carbon dioxide into the sealed chamber at a rate of 200 grams over 20 minutes, recording the initial cylinder weight. After 20 minutes, stop the gas flow, weigh the cylinder again to determine the released amount, and continue recording carbon dioxide levels until they return to the external air concentration. The volume of carbon dioxide measured by the carbon dioxide analyzer is in units of liters. It must be adjusted to grams then calculated as follows:
Recovery (%) = Measured Carbon Dioxide Weight (grams) x 100 / Carbon Dioxide Weight Released from Cylinder (grams)

**Photo library of your system:**

Fig. chambers with associated metabolic crates

Sketch with measurements of headbox – so somebody can copy design

Manufacturer's template for neck shroud construction

Personal contact directly.

Photo of airflow components

- Vortex blower and any air bleed-in valves
- Flow meter

Photo of gas analyser & and filter/dryer components

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| Photo of gas recovery in action. |
| END |

Photo of headbox

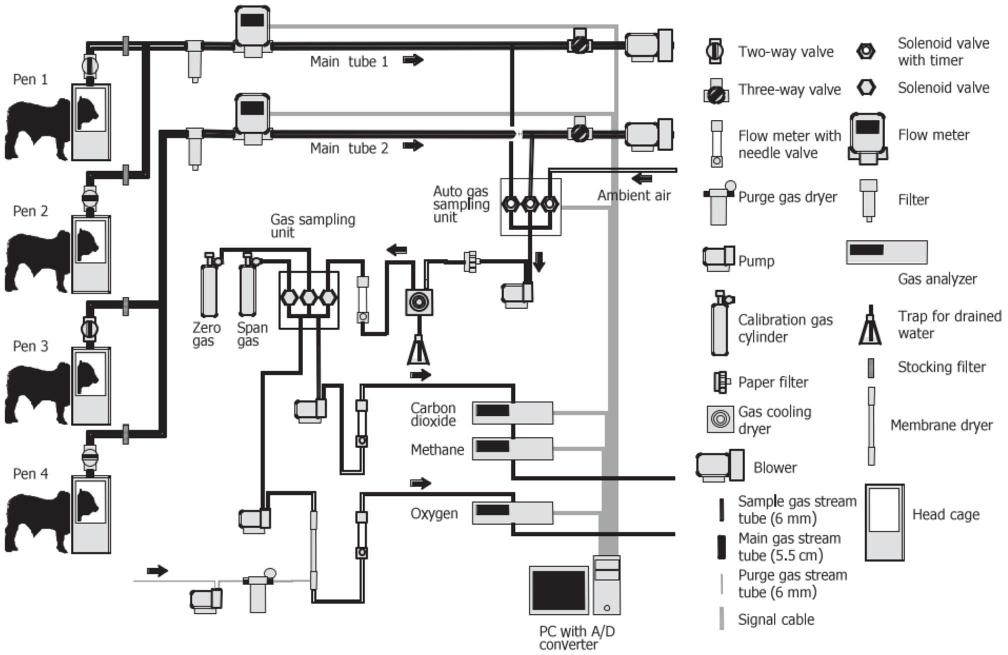


**Fig. 1. Schematic diagram of the ventilated hood-type respiration chamber system**
The black arrows indicate the direction of airflow through the system.

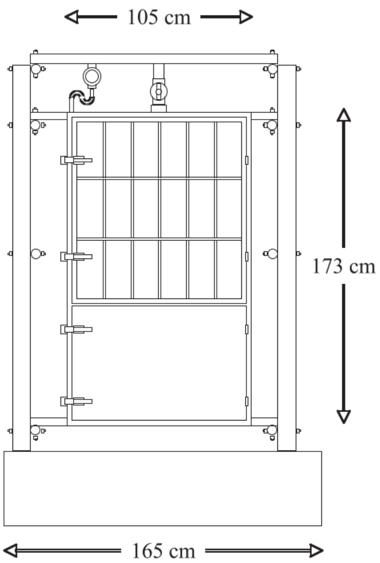


**Fig. 2. Front view of the head cage and digestion stall**

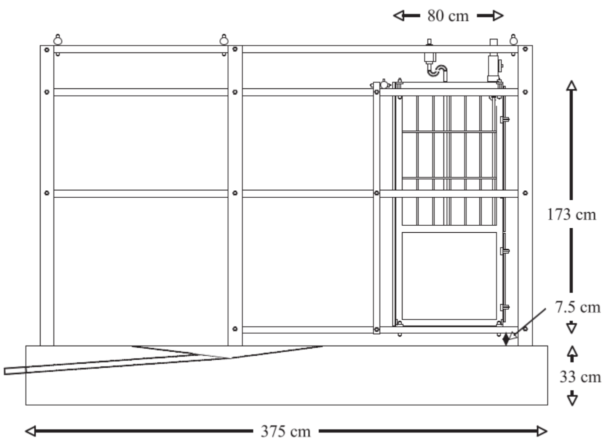


**Fig. 3. Side view of the head cage and digestion stall**

Fig.4 Headbox with hood

Fig.5 Feed bunk and automatic water bowl

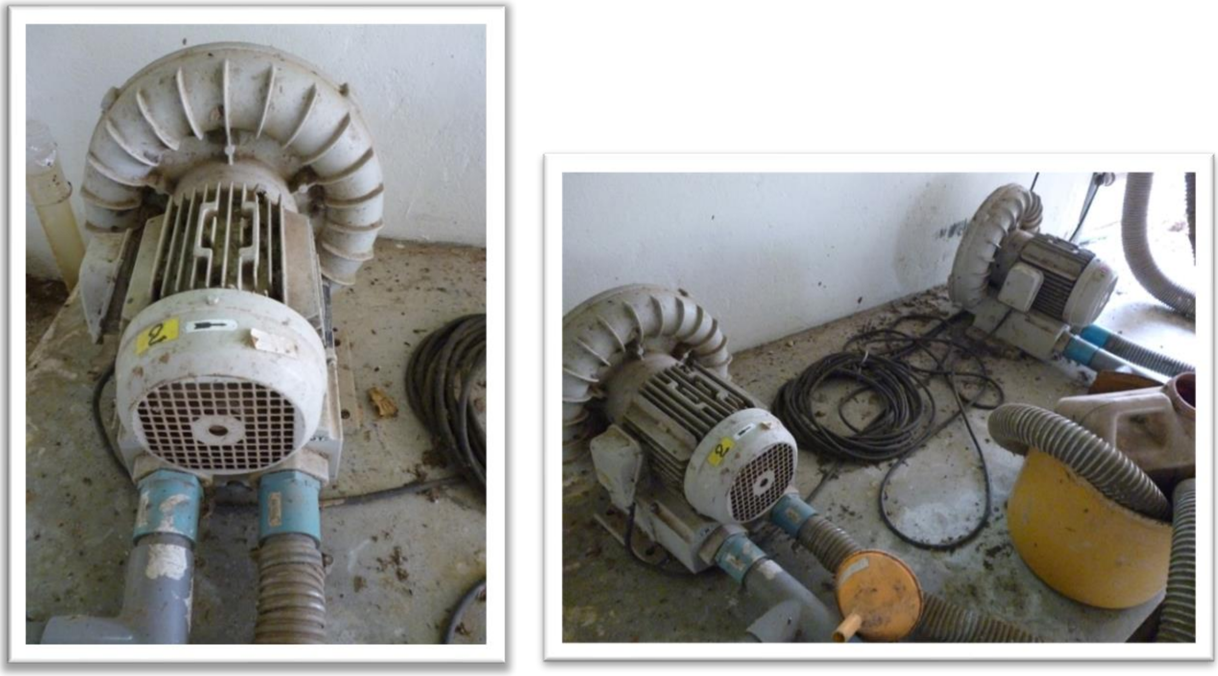

Fig.6 Vortex blowers

Fig.7 Flow meter and main air tube


Fig.8a Pump for air from the main air flow (12 L/min)

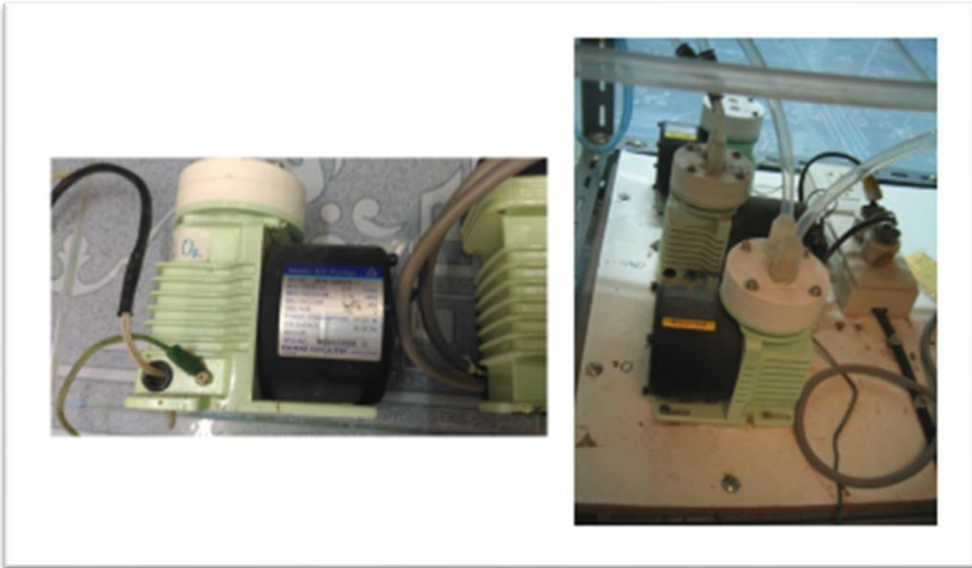

Fig. 8b Vacuum pump for $O_2$, $CO_2$ and $CH_4$ gas sampling (flow rate 7, 5 and 5 L/min)


Fig.9  Air cooling dryer

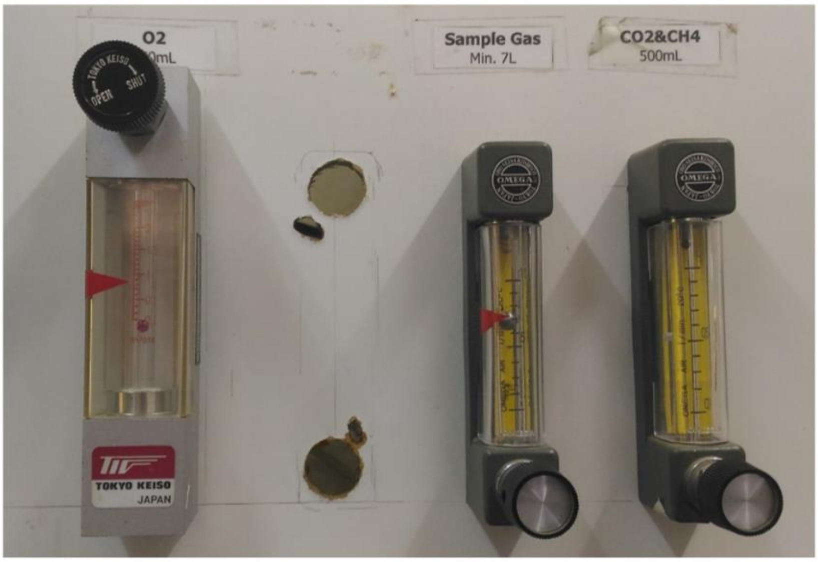


Fig.10  Flow meter with needle valve


Fig.11 Gas analyzers (Carbon dioxide, Methane and Oxygen)

Fig.12  Auto gas sampling unit

Fig.13  Dust filter

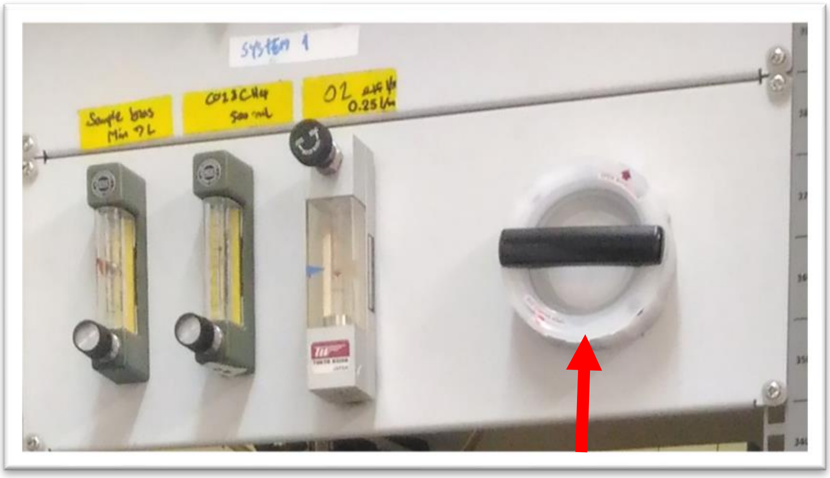

Fig.14 Polymer membrane filter

Fig.15 Recovery test