# GW Jets for simulation of gas agitation of solid particles in combustion tanks

## I. Purpose of the experiment:

1. Measure the air intake of the venturi jet during gas injection;
2. Simulate the agitation of the fuel particles by the venturi gas jet, and observe the loosening and prying of the particles by the GW jet.

## II. Experimental models

1. Geometric model: The customer is using a φ2000mm cylindrical tank with four GW jets installed around it. 1000×1000×1000mm glass cylinder container is used to simulate the working condition and range of action of one of the GW jets, and the container is made of glass material for easy observation.
2. Fuel particles: the customer uses coal particles with a particle size of 2mm and a stacking weight of 1200kg/m³. Considering that the temperature inside the tank is >1000℃ during actual combustion, the stacking weight of the fuel particles will be greatly reduced, so the experiment adopts particles with a particle size of 2mm and a stacking weight of 350~450kg/m³ to simulate the actual working conditions.
3. Power gas: The customer used oxygen as the power gas, and the experiment used air as the power gas. The density of oxygen is 1.4kg/m³ and the density of air is 1.23kg/m³, both of them have similar density, so it can simulate the actual working condition.
4. The experiments use 0.1MPa~0.4MPa compressed air for jet mixing simulation, which can observe the working conditions under different pressures.

## III. Experimental setup

A. Introduction to the device:
   1. Pneumatic device: provide 0.5MPa power air.

   2. Valve A: Pressure stabilizing tank control valve, adjust the gas pressure of the stabilizing tank.

   3. Pressure stabilizing tank: regulating air pressure, providing

stable pressure of powered air for jetting experiments

4. Valve B: GW Jet Inlet Control Valve.

5. Flowmeter A: DN50 vortex flowmeter, measuring the flow of powered air at the inlet of the GW injector; the factor that has a greater impact on the vortex flowmeter is the fluid pressure, so the pressure value of the flowmeter needs to be adjusted prior to each measurement.

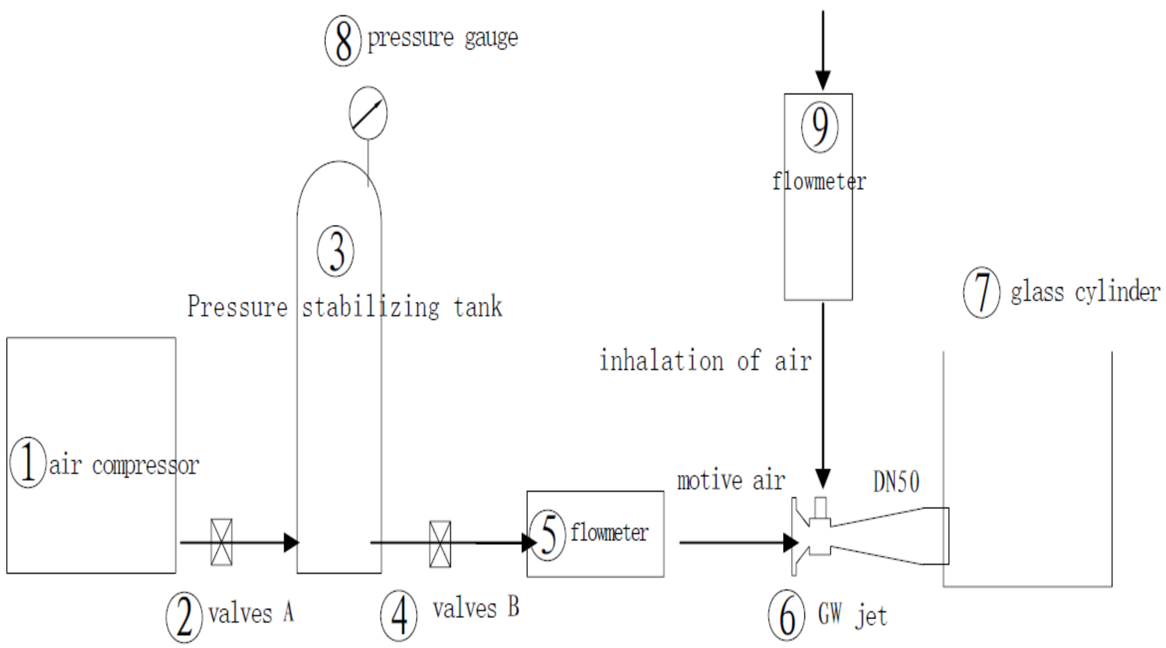
6. GW Jet: Jets air to agitate the particles and can draw in air at the same time.

7. Glass tanks: loaded with pellets, clear glass for easy viewing

8. Pressure gauge: Measurement of the pressure of the motive air in the stabilizer tank.

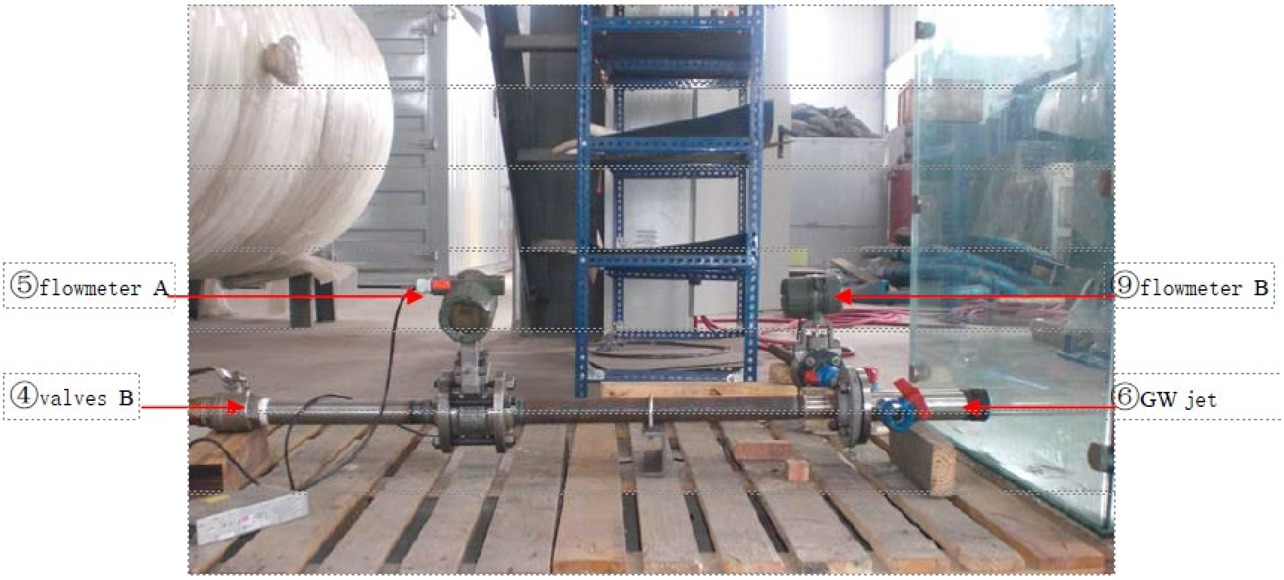
9. Flowmeter B: DN25 vortex flowmeter to measure the suction of the GW injector.

B. The experimental setup connections are shown in Figures A, B, C.




A.Schematic diagram of the experimental setup


B.Schematic diagram of the experimental setup




C. Schematic diagram of the experimental setup

## IV. Experimental steps and process

### 1, air intake

As shown in Figure 2 will be installed after the experimental device, by adjusting the valve A, control the pressure stabilization tank pressure at 0.04MPa, 0.05MPa and other values, open the valve B spray air, in the pressure gauge flow meter readings stabilized after recording data. Measurement data as shown in Table 1

| serial number | GW Jet Inlet | | GW Jet Suction |
|---|---|---|---|
| | stresses MPa | Flow ($m^3/h$) | Flow ($m^3/h$) |
| 1 | 0.04 | 166 | 30.3 |
| 2 | 0.05 | 185 | 25.8 |
| 3 | 0.08 | 352 | 20.1 |
| 4 | 0.1 | 440 | 17.8 |
| 5 | 0.15 | 562 | 12.3 |
| 6 | 0.2 | 670 | 0 |
| 7 | 0.3 | 960 | 0 |

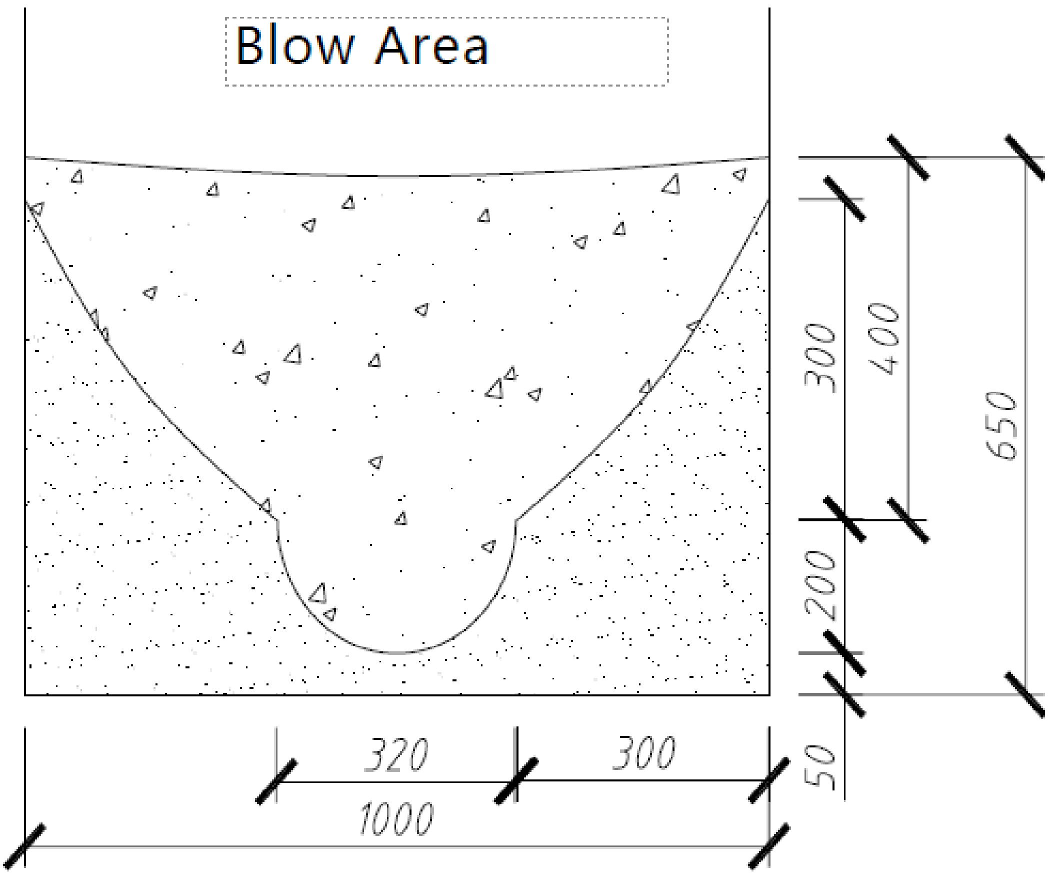
Table 1

At different pressures and with different air flows through the GW jet, the GW jet will draw in different amounts of air. At a pressure of 0.2MPa, the flow rate reaches $670m^3/h$, and the GW jet no longer draws in air. Since the pressure gauge could not accurately show the pressure of 0~0.04MPa, the vortex flowmeter could not work properly and could not measure the inlet flow of the GW injector, and the maximum value of the air intake was $30.3m^3/h$ at 0.04MPa.

## 2、 Air jet mixing

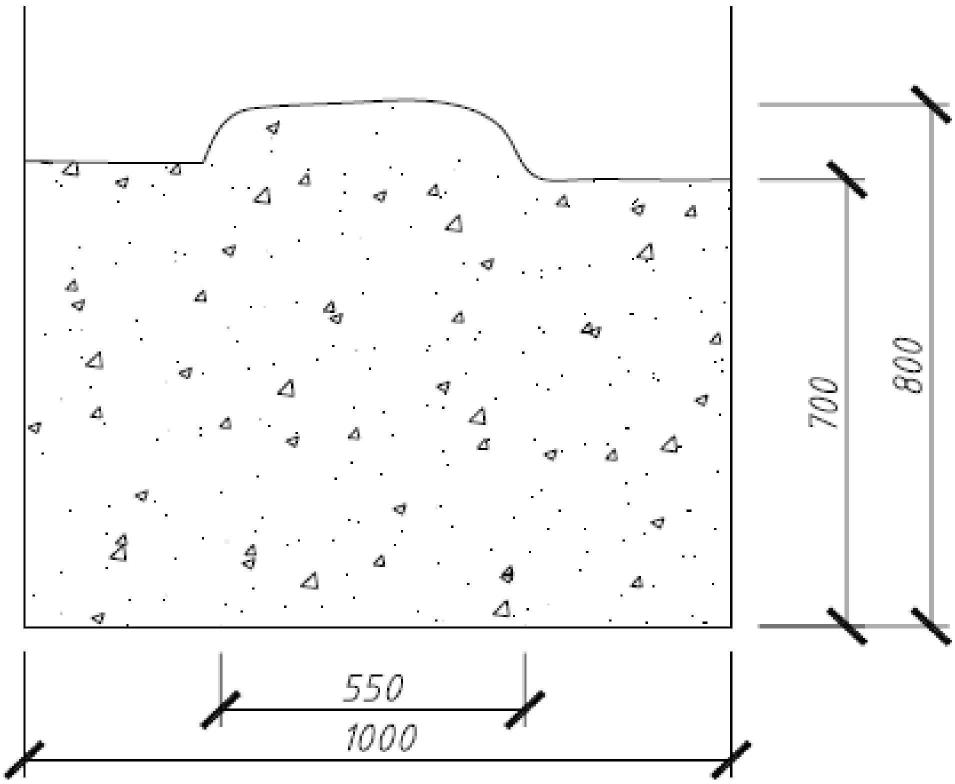
The experiment is divided into four groups, the particle thickness is increasing, respectively, 300mm, 500mm, 700mm, 800mm (particle thickness of the bottom of the container to the upper surface of the pile of particles), the control of powered air between 0.1 ~ 0.4MPa, to observe the phenomenon of stirring, the results of the observations are shown in Table 2.

| Serial No. | Particle thickness(mm) | particle weight(kg) | motive air-barometric (MPa) | stirring phenomenon |
|---|---|---|---|---|
| 1 | 300 | 100 | 0.1 | The pile of pellets is sprayed away and the pellets hit the back plate of the glass cylinder with the airflow and spread out in all directions. |
| 2 | | | 0.2 | The pile of pellets is rapidly sprayed away and the pellets hit the back plate of the glass cylinder violently with the airflow and spread out in all directions |
| 3 | 500 | 175 | 0.1 | The interior of the pellet pile is fluffy, the pellets float, and constant tumbling of the pellets can be observed from the lower part. |
| 4 | | | 0.2 | The pile of particles arches upward at first, and then the particles are sprayed upward with the airflow like a volcanic eruption. |
| 5 | | | 0.4 | Air flow through the front and back of the container, particles sprayed violently, from the rear view of the glass cylinder can be seen a large number of particles upward surge, violent tumbling, churning range as shown in Figure 4. |
| 6 | 700 | 250 | 0.2 | The particles as a whole to float upward, in the jet nozzle above the protruding particles of more than half a meter in diameter pile (Figure 5); can be observed in the middle of the particles have a large gap, particles in the gap in the churning; along with the protruding particles pile continues to expand, and finally the particles with the airflow such as a volcanic eruption of upward spewing. |
| 7 | | | 0.4 | The particles are ejected upward with the airflow like a volcanic eruption, and the churning traces are shown in Fig. 7. |
| 8 | 800 | 300 | 0.4 | The particles are ejected upward with the airflow like a volcanic eruption. |

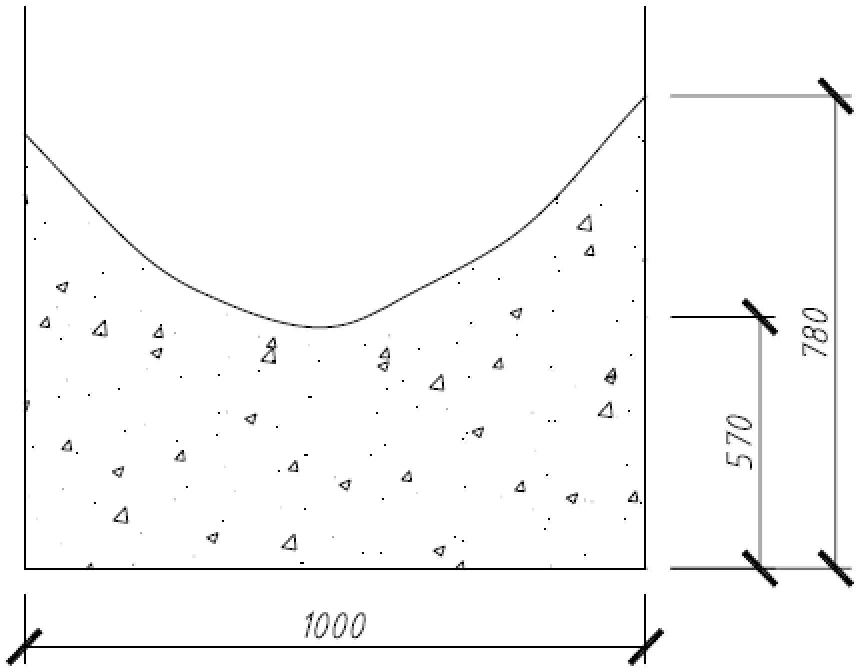


Pic 4 500mm thick 0.4MPa pressure particle movement traces

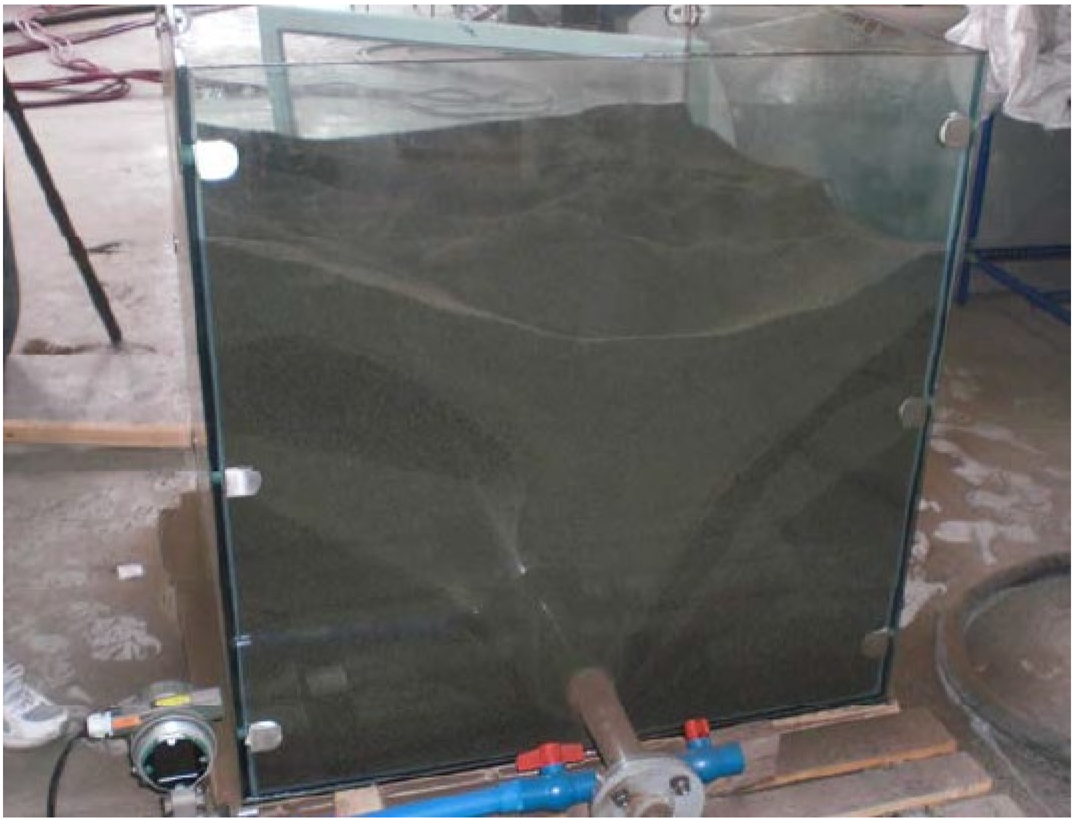
Note: The traces of particle motion in the figure indicate that the airflow traversed the particle pile, stirring the particulate material as a whole.




Pic 5 Schematic diagram of particle state under 0.2MPa pressure for 700mm thickness




Pic 6 Schematic diagram of the particle state after stopping aeration at 0.2MPa pressure for 700mm.



Pic 7 700mm 0.4MPa Stirring traces

## V. Experimental conclusions

1. Air intake

With no particles in the glass cylinder and no resistance at the outlet of the GW Jet, different flow rates and corresponding suction volumes of the GW Jet can be measured by adjusting the pressure of different motive air.

When the pressure of motive air is less than 0.04MPa and the flow rate at the inlet of the GW injector is less than 166$m^3$/h, the suction volume of the GW injector increases with the flow rate at higher air pressure.

The maximum suction volume of the GW jet was measured to be 30.3 $m^3$/h at a pressure of 0.04 MPa of motive air and a flow rate of 166 $m^3$/h at the inlet of the GW jet.

When the pressure of the motive air is greater than 0.04 MPa and the flow rate at the inlet of the GW injector is greater than 166 $m^3$/h, the suction volume decreases as the flow rate increases with higher air pressure.

2、Jet mixing

Experimentally, it is proved that when gas is injected into solid particles by GW jet, when the gas pressure is 0.1MPa, the inside of the pile of particles is fluffy, the particles are floating and tumbling (as in the video 500mm0.1MPa for 50 seconds). When the gas pressure is 0.2MPa, the particles will float with the gas flow as a whole, forming a large gap in the center, in a fluffy state (such as video 700mm0.2MPa time 2 minutes), after a period of time, the particles are ejected upward like a volcano eruption. When the gas pressure is greater than 0.2MPa, the particles will immediately be ejected upwards and flip like a volcanic eruption.

At room temperature GW jet for particle mixing, 0.1 ~ 0.2MPa air pressure can make the particles overall lift, the formation of gaps in the middle, the particles continue to roll, after a period of time, the particles such as a volcanic eruption upward jet. In the combustion of fuel particles to achieve a good mixing effect, only need to make the particles fluffy, in the middle of the formation of a gap, do not need to be like a volcanic eruption like jet violent mixing, so the use of less than 0.1MPa of air pressure can achieve the mixing effect. In the high temperature combustion state, the gas is heated by the rapid expansion, in order to make the particles to achieve the effect of fluffy, the required pressure and flow of power air will be less than the pressure and flow at room temperature.

GW Jets can be used for gas stirring of solid particles in combustion tanks to achieve very good results.

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