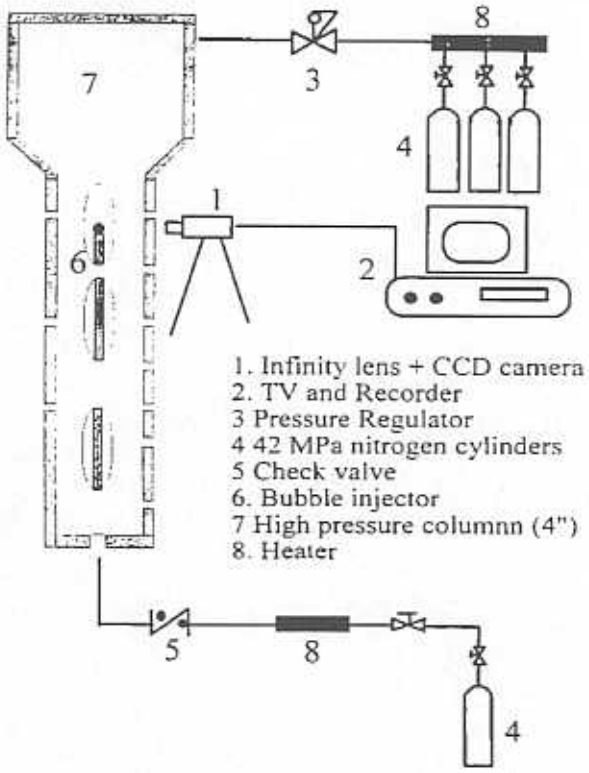


Figure 3.13. Surface tension measurement apparatus setup.

## 4. SUGGESTED SYSTEM TO BE USED

The gas-liquid-solid system that will be used in the hydrodynamics investigations of slurry bubble column has been selected based on the physical properties of the FT waxes reviewed in section 2 for liquid phase and based on the capabilities of the available experimental facilities and measurement techniques discussed in section 3 for the gas and solids phases. According to the discussion below, the selected system that will be used to conduct the needed hydrodynamics investigations in 2-inch and 6-inch diameter slurry bubble column reactors is air-Exxon Norpar 14-glass beads.

**Liquid phase:**

As discussed in section 2, a wide range of FT wax properties have been used. Table 4.1 list the range of density, viscosity and surface tension of the FT waxes used at FT reaction conditions.

Table 4.1. Range of FT waxes properties used

| Temperature C° | Density $Kg/m^3$ | Viscosity cP | Surface Tension dyne/cm |
|---|---|---|---|
| 25 – 300 | 655 – 849 | 0.55 – 38.13 | 16 – 29.1 |

Accordingly, Exxon Norpar 14 at room temperature has been selected since it would mimic the hydrodynamics of FT waxes at FT operating conditions. The physical properties of Exxon Norpar 14 at room temperature are as follows:

**Density**: 770 kg/m$^3$
**Viscosity**: 2.2 cP
**Surface tension**: 25 dyne/cm

**Gas phase**:

As discussed in section 3, the high pressure 6" inch diameter slurry bubble column facility can be operated at pressure up to 200 psig at room temperature. It is equipped with an air compressor which provides up to 310 SCFM at these conditions. The facility has been designed to implement CARPT and CT techniques at high pressure and high superficial gas velocity. Since CARPT and CT have not been used to investigate the effect of high pressure and high gas velocity on the flow pattern, turbulent parameter and phase distribution in 6 inch slurry bubble column and since the implementation of these techniques at these conditions is not trivial, CARPT and CT will be used first to investigate at room temperature the effect of pressure and high gas velocity in slurry bubble column using air compressor. Accordingly, air has been selected as the gas phase. It is noteworthy that we have obtained in the Chemical Reaction Engineering Laboratory (CREL) – Washington University an extensive database of CARPT and CT in air-water system. By using air-Exxon Norpar 14 system, we will study the effect of the physical properties on the measure hydrodynamic parameters.

**Solids phase**:

CARPT technique will be used to monitor the solids flow pattern and to measure in a non-invasive manner the solids recirculation velocity and turbulent parameters. By combining CARPT/CT/$\Delta$p measurements the three phase distribution will be measured radially and axially. As mentioned earlier, CARPT relies on tracking a radioactive tracer particle of the same size and density of the solids used. In our laboratory we have used composite particles of scandium, polypropylene and air of sizes between 2 mm and 2.5 mm as the tracer particles. During this year we have evaluated the possibility of using a scandium radioactive particle with a size similar or close to the FT catalysis size. We found that a scandium particle of 300-150 μm diameter can be obtained (density = 2.99 g/cm$^3$). Since scandium is a highly reactive metal a nonreactor thin layer of coating is required. A parylene N has been selelcted to coat scandium particles since it has desirable thermal and mechanical properties (density = 1.11 gm/cm$^3$). According to the density of these materials, a spherical particles of 300 – 150 μm can be obtained with a density range between 2 – 2.8 gm/cm$^3$ based on the thickness of the coating. Therefore, a density and shape of glass beads particles (~2.4 gm/cm$^3$) can be matched with scandium coated by N parylene. Hence, in order to implement CARPT technique successfully for the first time in slurry bubble column operated under high pressure and high gas velocity and to obtain for the first time the flow pattern, turbulent parameters and phase distribution, glass beads particles of 150 μm to 300 μm diameter have been selected as the solids system.