Annexure-1

Online Coal Characterisation Sensor

Purpose of the Product:

A compact automated equipment is to be built to characterise powdered coal, collected as sample in small quantities from acontinuous coal conveyor line feeding to the boiler furnace. Characterisation of coal covers composition of moisture, ash content, carbon and volatiles, which is used to adjust the operating parameters of the boiler furnace. This prototype meant for BHEL, when proved to be successful, will be replicated in more numbers.

Product Description and Operating Principle

A typical automated unit consists of a fabricatedand sealed Coal characterization chamber,an induction heater and its power supply, cooling system for the induction coil, and a gas monitoring and control system. Collecting the sample coal, carrying to induction heater, heating to specified temperatures and emptying the cup are to be automated in required sequence, with suitable sensors and measuring devices and with a control system capturing data on weight of coal versus temperature and gas sampling.

The goal is to take in accurately weighed coal powder (sample weight range 5 to 10 grams), in a steel cup, place it inside the induction coil heater, the cup is heated upto maximum 900°C with controlled temperature to remove all the water vapour and volatile gases in the coal powder, weight reduction of the coal powder should be directly and accurately measured by load cell based weight measurement. At the end of the full cycle, the coal powder has to be dumped out of the sensor assembly, by inverting the cup into a receiver and then conveyed out of the chamber.After this another fresh coal powder has to be sampled.

The heating is in three stages, with a short duration of constant temperature in between. The chamber will have to be air tight and will have to be filled with Argon, and its oxygen concentration continuously monitored to avoid coal catching fire. The Temperature of the cup and the coal are to be monitored at specific timings. The coal in and out must happen through screw conveyor (preferably single screw). The cycle timings and temperature stop points are to be settable. This whole assembly is expected to be working in a dusty environment of a coal boiler setting. Thus the assembly should have good dust (coal or ash) resistance.

The equipment shouldbe completely automated using appropriate control systems with suitable software programming. Display and parameter settings shall be through a touch screen. The significant parameters to be captured for temperature, weight, time. The control system should have adequate memory for data storage and ports for communicating with external computer/laptop.

Specifications:

1. CHAMBER:
    - Chamber should have dimensions of 400×400×400 mm approximately,made of SS304. It can be smaller if possible, without losing any functionality. Smaller volume will mean easier to fill argon but will also cause problems in heat radiation and any leak of air can easily cause fire.
    - It should be completely leak and dust proof with operating pressure of 1bar and 900 degree Celsius with argon inside. The ambience outisde the chamber will be room air.
    - Need provisions for argon purging and venting(1/4 inch BSP female connection, 2 No.s)

- The chamber should have an Oxygen detector to monitor the oxygen level in the chamber. The oxygen level of <5%must be maintained by controlling argon inert gas flow. Argon gas will be supplied (not in scope of tender) approximately atmospheric pressures.
- Chamber inside must have black oxide coating (non-shiny, to suppress radiation reflections inside)
- Minimum three side transparent windows(ordinary crystal clear glass) and one side leak proof door with toggle clamping arrangement. The glass windows may be pasted onto a frame and screwed on to chamber.
- Need provisions for gas analysis (1/2 inch BSP female connection, 2 Nos.). The ports should be such that one can introduce a 1/4 inch tube through the port and take samples close to the exit of the cup.
- Need to provide k-type thermocouple to detect chamber inside gas temperature.

2. SCREW FEEDER MECHANISM :
    - Screw feeder can be used to convey pulverized coal powder into and out of the chamber
    - Screw feeder should be fully automatically controlled by stepper motor
    - EPV should be providedin and out of the screw feeder to minimise atmospheric air entering and mixing with chamber gas. The EPV should work even with some coal powder in it.
    - Screw feeder should bring 5 to 10 grams of pulverized coal powder into the cup
    - Screw feeder material should be SS304 for corrosion control
    - Stepper motor should be protected from dust and heat
    - The clearance should be such that the coal powder of 5 to 2000 micro meter in size cannot get stuck and stop the screw mechanism.

3. TRAVERSE MECHANISM WITH CUP HOLDING:
    - Cup is made of MS, Dimension of cup 30mm diameter, 45mm height, 2mm thickness.
    - Rim of cup can be as per individual designs of gripper.
    - The traverse mechanism must be such that the cup can load coal powder from under the outlet of the screw feeder conveyor, then rotate and/or translate to above the heater coil, then insert the cup inside the coil, with only the gripper out of the coil, then after heating cycle is over, the cup must be brought to above the screw feeder collection point and then invert the cup to pour out the coal.
    - The arm holding cup must have a load cell in line in the cantilever
    - The arm cannot conduct heat from the cup to the actuation mechanisms
    - 3-Axis movement with automated by stepper motor(First axis-cup move up and down, second axis -Traverse column rotate left and right to make position of cup ,Third axis-cup rotates 180 degrees to remove all the processed coal powder)
    - Cup should be rotated 180 degree to invert the cup and pour the heated coal out of cup.
    - All rotation parts including stepper motor free from dust and must be insulated from high temperature
    - Traverse must have provision for automatic recalibration /home position to provide for correction in case there is a drift in position
    - The traverse must have an accuracy of 0 to 3mm in position.

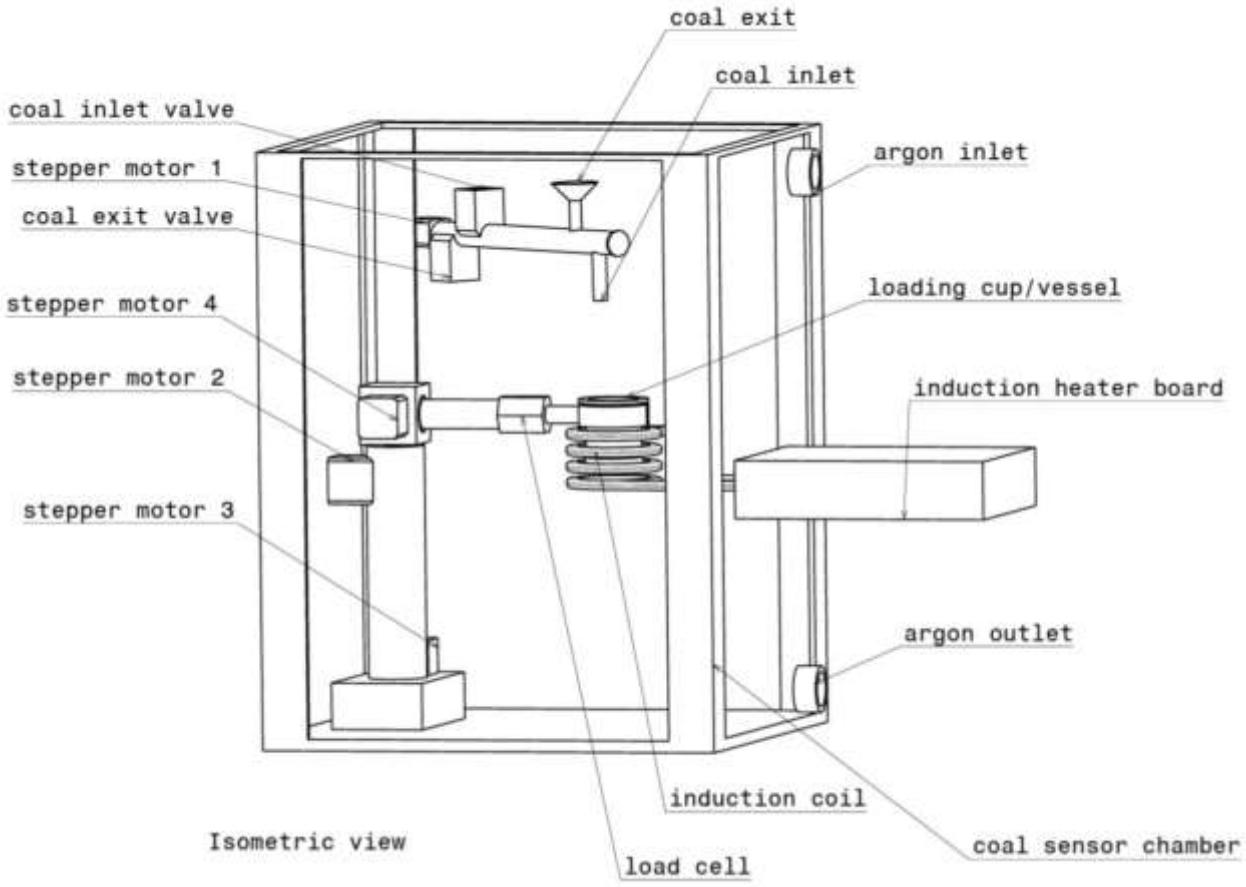
4. HEATING COIL AND POWER SUPPLY:
    - Induction heating should beused
    - Cup should not touch the heating coil

- 2500Watts power supply should be used
- Heating coils needs water cooling, coils need crucible coating
- Coils made of copper, 6mm diameter of copper tube, Coil diameter more than cup diameter to allow for effective insertion of cup and removal, while still achieving high temperatures upto 900 deg C
- Coil attached power supply insulated from dust and temperature
- Induction heating coil and attached power supply should be moveable up and down based on requirement(Manual movement)
- Heater coil should heat the cup to maximum 900 degree Celsius or slightly more
- Temperature controller is needed to control the temperature and maintain the temperature for few minutes(four step control 100,400,600,900 degree Celsius)
- IR Temperature measuring instrument can be used to measure both cup and coal temperature
- Insulation of the electronic devices from electromagnetic radiation during the induction heating must also be done in order to avoid malfunction

5. Load Cell:
    - Load cell sensitivity should be 0.01grams or finer
    - Load cell mounted inline on the cup holding arm (cantilever type)
    - Temperature insulation is needed for load cell
    - Electromagnetic insulation is needed for load cell
    - Load cell should be insulated from dust, heat and electromagnetic radiation.
    - The load cell should manage to measure cup weight + coal weight of 10 gms max, and gripper weight at any time. Max load of the load cell is depending on the cup gripping mechanism weight.

6. Control System
    - System should be integrated by NI or suitable embedded system. If it required a laptop, that is also included in the scope of supplier.
    - All automation
        - Screw feeder(Qty-1), Traverse Mechanism with Stepper motor(Qty-4)
        - Temperature sensor(IR based Qty-2,Thermocouple Qty-1) as mentioned above
        - Load cell(Qty-1)
        - EPV(Qty-2)for coal, Solenoidvalue(Qty-2) for Argon supply
        - Induction heatingmodules, power supply and coil cooling unit(Qty-1)
        - Oxygen sensor (Qty-1)
        - Pressure monitoring sensor for the chamber (Qty -1)
    - Temperature vs Weight reduction, based on time online monitor output
    - Display unit and data storage, output in Excel format also needed for recording all the channels of data acquired
    - Provision to mount the control system on the mobile trolley or operated remotely from min10 metres from the unit. Suitable cables to be provided

7. Complete equipment to be mounted on portable trolley for mobility



Model representation:

Chronology of time sequence of operation in second:

Start time	End time	Actions
0000	0005	EPV-1 should be open, SM-1 should be operated to deliver the pulverized coal powder (5-10 grams)into the cup
0005	0010	Required weight of coal is collected, SM-1 should stop, EPV-1 should be closed. Weight of coal should be measured, and should stop when it is required coal amount. Excess coal powder from the screw feeder is removed by opening EPV-2 and operating the screw feeder in reverse.
0010	0015	SM-2 and SM-3 should operate, to move the cup from below the screw feeder to above the coil center. This can be a linear traverse for height and rotational traverse (move by a fixed angle) for movement from feeder to coil such that the axes of the cup and the heating coils coincide
0015	0019	SM-3 should operate, cup is moving up and down to make position (to insert the cup inside the coil)
0019	0020	Switch on the induction heater power supply, Cooling on, Heater on
0020	0060	Maintain 100 degree Celsius for 30 second, measure the weight, Data is given for processing

0060	0100	Maintain 400 degree Celsius for 30 second, measure the weight,Data is given for processing
0100	0140	Maintain 600 degree Celsius for 30 second, measure the weight,Data is given for processing
0140	0180	Maintain 900 degree Celsius for 30 second, measure the weight,Data is given for processing
0180	0181	Switch off both heater and cooling unit
0181	0184	Plot the results weight reduction based on temperature for a given time
		Time for LASER measurements
0184	0187	SM-3 should operate, move the cup out from the coil
0187	0190	SM-2 should operate, rotates with fixed radius to a given angle such that it is above the used coal receiver above the screw conveyor
0190	0200	SM-4 should operate, cup revolve 180 degree (inverted), pour all the remaining coal particles from the cup, and then come back to original upright position
0200	0205	EPV-2 should be open, SM-1 should operate to remove all the used coal particles
0205	0207	SM-1 should be stopped, EPV-2 should be closed
0207		Next cycle should be starts....

Note: Vendor should also consider, multiple process can be at the same time without affecting the sequences of operation to reduce the time of entire cycle.

Terms and conditions:

- Vendor should adhere to all the specifications mentioned above
- Technical certificates, specifications are needed for all the components used
- System integration and proving of proper functioning of the equipment should be provided at both IITMadras and customer site locations
- All the components quoted in the Tender bid should be covered under warranty for 2 years
- On-site warranty service for the duration of the warranty period
- Vendor should provide continuous technical support and maintenance of work done
- Vendor must have previous work experience in the field of mechanical fabrication and automation
- Operation and maintenance manuals to be submitted
- Vendor should follow all safety standards for heating modules, power supply installations
- Pre-bid meeting will be conducted online.
- Delivery within 60 days of receipt of purchase order
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