Semi-industrial Carbonization Tests

in the

DMT Movable Wall Oven

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Semi-industrial movable wall coke oven

DMT is operating a movable wall oven with underfired natural gas heating flues. The chamber width is flexible and can be varied in three dimensions (450, 600 and 750 mm). The capacity of the oven is 450 to 1,500 kg depend on chamber width and bulk density.

The refractory brick work consists of silica bricks and the heating flues have similar cross cut dimensions as those of the industrial scale oven. Therefore the heat transfer from the heating walls into the coal charge occurs in a very similar manner compared with the industrial scale plant. Thus an optimum simulation of the plant conditions is guaranteed.

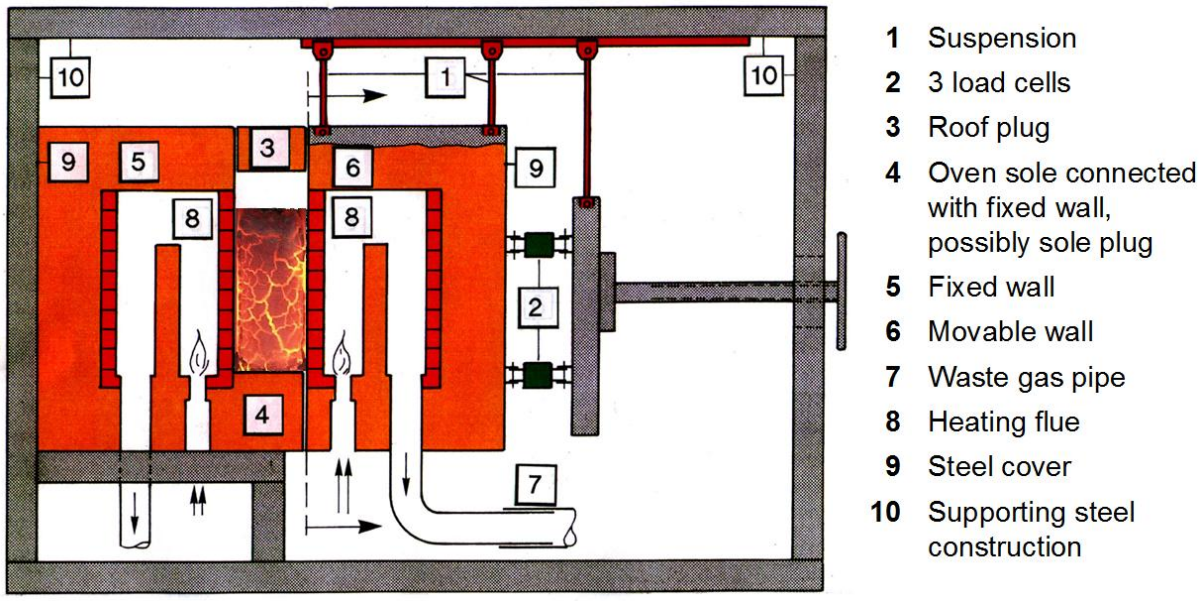

Figure 1: Semi-industrial carbonization test oven with movable wall

Structure and dimensions of the semi-industrial coke oven used by DMT are shown in **Fig. 1** and **Fig. 2**. **Fig. 1** displays a cross cut of the movable wall oven. The chamber width is the decisive dimension for the heat transfer from the heating walls to the coal charge and is simulated in the semi-industrial scale 1:1. Length and height of the coke

oven chamber are reduced quite significantly: the distance between the door plugs is approx. 1.3 m and the charging height approx. 1.0 m.

The particular feature of the semi-industrial coke oven is its ability to modify chamber width in three dimensions (450, 600 and 750 mm). Besides from the possibility to vary the chamber width the movable wall oven has the advantage that the forces exerted to the movable wall during carbonization by the swelling pressure of the charge can directly be monitored via load cells.

Moreover, the internal gas pressure, the course of temperature in the coal charge center and the coal charge shrinkage are determined by means of adequate probes (see **Fig. 2**).

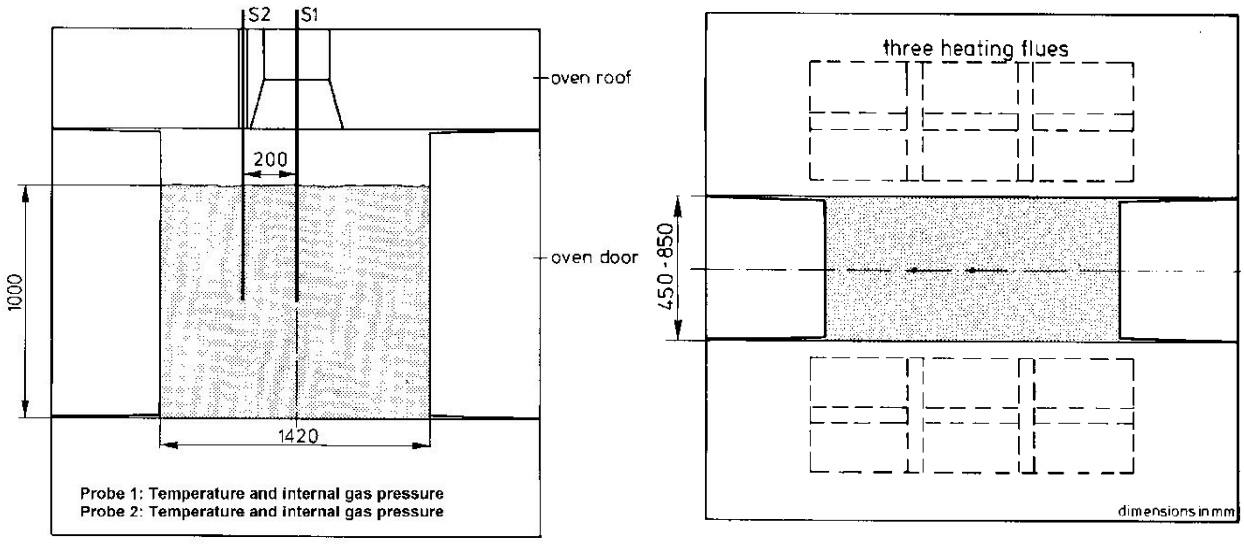

Figure 2: Semi-industrial coke oven – dimensions

The semi-industrial coke oven can be charged either by gravity or by stamp charging. The charge weight ranges between approx. 500 and 1,500 kg (depending on chamber width and coal bulk density). The produced amount of coke is sufficient for the determination of all the usual coke quality indices.

Additionally, the exactly simulated operating conditions (concerning size distribution, moisture content, bulk density and heating flue temperature) allow to produce reliable results for the plant operator in terms of the swelling behavior of the coal charge and the resulting coke quality.

Procedure for the semi-industrial MWO test

Coal preparation - Top charging

The delivered single coals are mixed according to blending program. The blended coal charge is crushed by an impact crusher to get the desired grain size distribution. The individual crushing of coal components are as well realizable. The homogenization, moisture content adjustment and oiling occurs in a mixer. Oiling is needed if the desired bulk density in the semi-industrial movable wall oven is not achievable by the mixture water and coal. The oiling does not affect the other results. The bulk density is determined in a bulk density cold chamber and is shown in. **Fig. 3**.

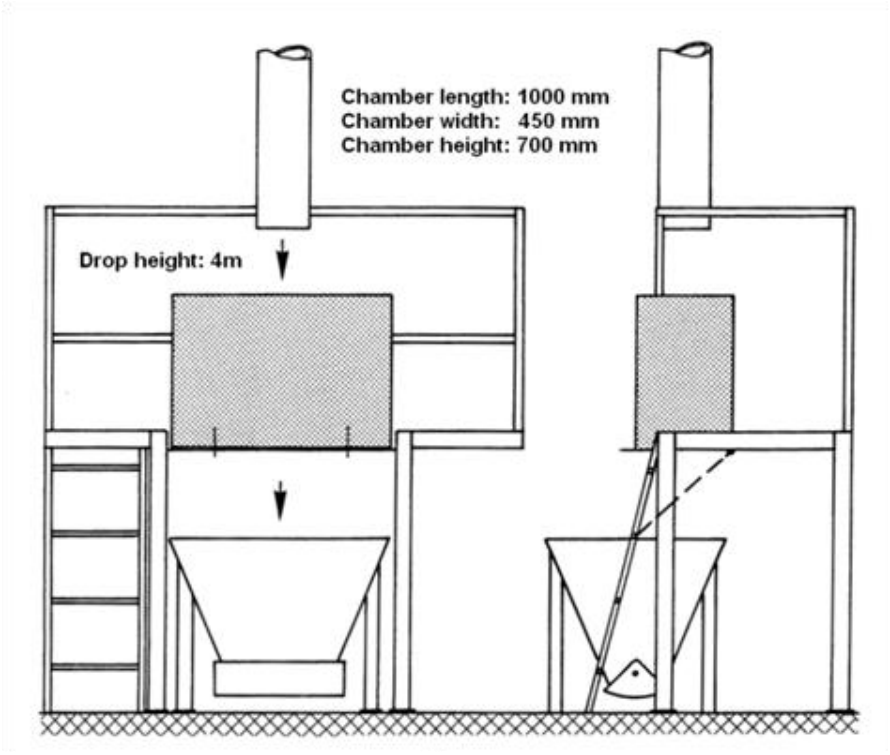

Figure 3: Bulk density cold chamber

The fall height is 4 m and corresponds with the charging height of the semi-industrial coke oven. The resulting bulk density in the test chamber will be achieved in the movable coke oven in the range of ± 10 kg/m³.

The coal bin with the prepared coal/coal blend is connected with a transition pipe to the charging hole on the top of the semi-industrial MWO during the charging phase. The resulting charging height is 4m. The real charging height is determined after leveling and enables to calculate the real bulk density in the coke oven.

Coal preparation - Stamp charging

The delivered single coals are mixed according to blending program. The blended coal charge is crushed by an impact crusher to get the desired grain size distribution. The individual crushing of coal components are as well realizable. The homogenization and moisture content adjustment occurs in a mixer. The coal cake for stamp charging is prepared manually in a stamping box visualised in **Fig. 4**.

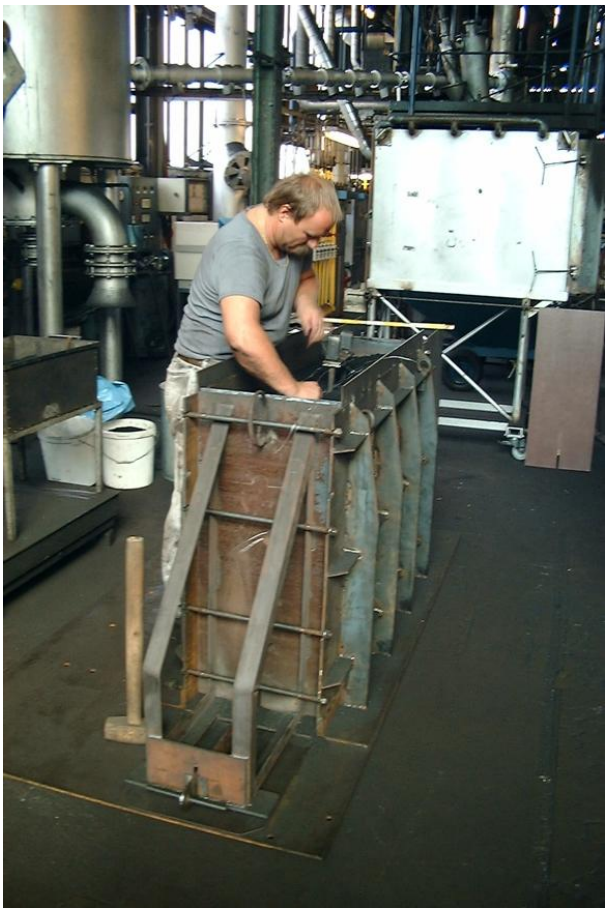

Figure 4: Stamp charging box for the movable wall oven

The coal is charged into the box in 10 layers, each layer has a thickness of 10 cm. Each layer is compacted separately to the desired stamp charging density. **Fig. 5** shows one wall of the stamping box with the marking lines for each layer.

Figure 5: Marking lines for the individual layers in the stamping box

Two protection tubes are incorporated into the upper layers of the coal cake, as to be seen in **Fig. 6**. These protection tubes are removed when the preparation of the stamped cake has been completed and the coal cake is going to be charged into the carbonisation test oven. Once the stamped cake has reached its correct position in the oven the probes for temperature and internal gas pressure measurement are introduced into the holes where the protection tubes had been before.

Figure 6: Facility of protection tubes to save the free space for monitoring probes positioning

The dimensions of the stamped cake at 450 mm chamber width are:

Length: ≈ 1300 mm

Width: ≈ 425 mm

Height: 1000 mm

Carbonization in the MWO

Details of the semi-industrial MWO are shown in **Fig. 1** and **Fig. 2**. During the coking process the following parameters are monitored:

- temperature in the centre of the charge (S1 / S2 probes in **Fig. 2**)

- internal gas pressure (S1 / S2 probes in **Fig. 2**)

-wall load (3 load cells, **Fig. 1**)

- lateral shrinkage of the charge.

The lateral shrinkage is measured by two heatproof discs between the charge and the fixed heating wall. The two outside positioned distance sensors are in contact with the discs via ceramic rods. **Fig. 7** shows the cast discs and the measurement arrangement.

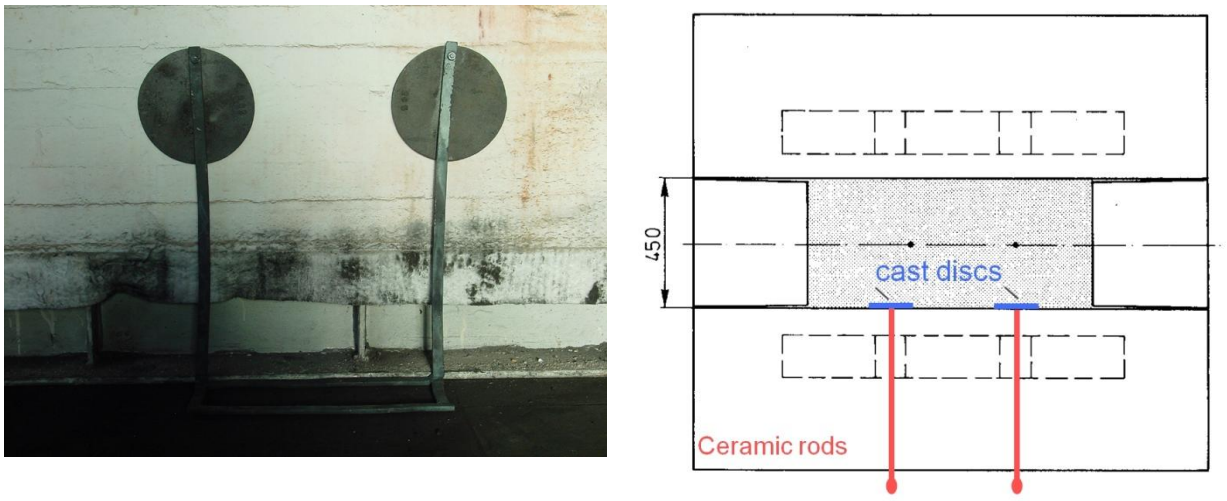

Figure 7: Lateral shrinkage measurement

The DMT standard pushing criterion often determines the end of the carbonization. The pushing criterion is reached after 3 hours of soaking time. The soaking time begins by a temperature of 900°C in the center of the charge. Other pushing criteria can as well realized like pushing after exact coking time or reaching of defined coke end

temperature. The coke is pushed into a double-wall coke cooling box. The cooling occurs indirectly with water flow in the double shell of the cooling box.

Coke treatment

The first step before the coke quality testing is the stabilization of the coke after the removal from the cooling box. The coke stabilization facility is shown by **Fig. 8**. The stabilization simulates the normal mechanical stress at the pushing sequence, wet quenching and transport at the industrial scale coke plant. The resulting grain size distribution is comparable to a grain size distribution at the industrial-scale plant. The coke is dropped from a height of 4 m onto a steel plate inclined by 45° at the stabilization facility. DMT standard includes three times dropping. The amount of dropping can vary depending on the customer requirement or plant specification.

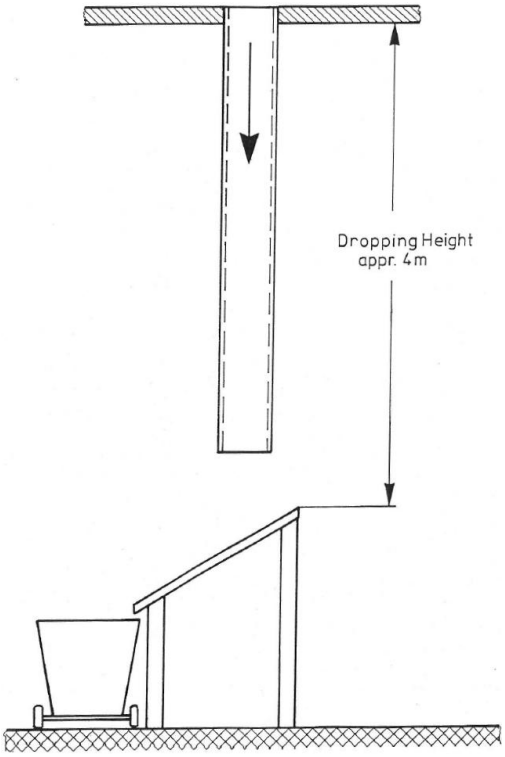

Figure 8: Coke stabilization facility

Coke testing occurs on the stabilized and sieved coke sample according to the following standards:

Mechanical strength tests → ISO 551,

ASTM D 3402 and JIS K 2151

CRI and CSR determination → ISO 18894 or ASTM D 5341.