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NOISE EMISSION OF A 250 MW COAL GASIFICATION PLANT FOR ELECTRICITY GENERATION

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1. INTRODUCTION

In the Netherlands a unique power plant has been realised. The source of energy is coal, which is not directly burned in a furnace, but is first gasified. This syngas can be used as fuel for a modern gasturbine. The size of this coal gasification plant is the largest in the world. The environmental performance of such a plant is much better than other types of coal using power plants. The first few years, the coal gasification plant is used to further develop and optimise its technology.

2. DIVIDING INTO PLANT SECTIONS

First the coal is grinded and dried. Then, the pulverised coal reacts with pure oxygen. The result is syngas. The next step is gas purification and saturation. Now, the syngas is ready to be used as fuel in a gasturbine. In the waste heat boiler the hot exhaust gases produce steam. As the process needs pure oxygen and nitrogen, an air separation plant was built. Figure 1 shows the basic processess of the plant sections.

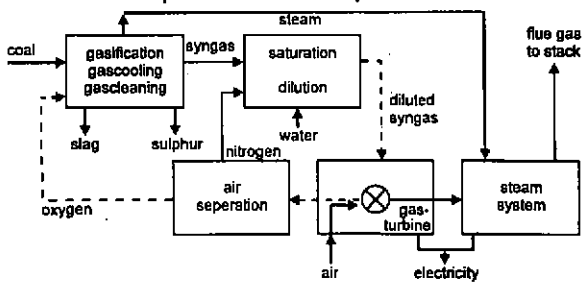

Fig. 1: Flow diagram of the basic processes

3. NOISE ASPECTS PER PLANT SECTION

During the initial studies the noise aspects were closely taken into account, as the noise limits in the environmental permit are rather severe. The nearest house is approximately at a distance of 300 meter with an allowable sound level of 49 dB(A) nightvalue according to the Dutch calculation method IL-HR-13-01 [1]). This equals an overall emission relevant sound power level of 114 dB(A).
Some parts are well-known technologies, so the noise aspects could be predicted quite well. However, the gasifier contained a lot of new technology. There are a few examples of gasification plants from which noise data could be used. The Dutch plant is much larger, so any direct comparison is not possible. In the first phase of the project some assumptions regarding the noise emission had to be made.

The **coal treatment** is known technology. The overall emitted sound power is 103 dB(A) (ref. 1 pW). The coal is transported from the coal storage to the grinding building by conveyer belts. These belts are fully enclosed. Inside the grinding building there are three large bunkers, so it is not necessary to operate any cranes at the coal storage during the night. This is a rather important noise aspect. The building is partly constructed with sound absorbing walls, for the natural ventilation special acoustic louvres were used. The transport system of the pulverised coal uses large fans. Both the fans and electric motor are specially insulated. The pneumatic filter cleaning mechanisms on top of the roof were additionally silenced by filling the "rain enclosures" with absorbing material.

As noticed before, the **gasification plant** contains a lot of new technology. The heart of this plant is the gasifier and syngas cooler. Based on the physical construction of these parts and combined with information on the chemical processes, *dgmr* made a prediction of the resulting sound power level. By using an empirical formulae derived by Snellink [2] the sound power inside the gasifier/syngas cooler was estimated to be no more than 125 dB(A). When taking into account the attenuation from the specific wall constructions the emitted sound power level is 80 dB(A) at the highest. After construction these installations were very quiet indeed. The overall sound power level of 109 dB(A) originates mostly from some large compressors.

The **desulphurization plant** is standard technology with an overall sound power of 106 dB(A). All acoustic measures were standard procedure.

The **air separation unit** seemed to be more or less standard as well. In practice this plant was the most difficult one with respect to noise aspects. Several problems with defect valves and seals occurred, which generated

a lot of incidental noise. After a plant shutdown, additional noise emission occurred due to nitrogen and oxygen venting to atmosphere through silencers. Some additional acoustic measures were carried out, mostly insulation of piping noise. The design of the plant was based on a normal start-up, after which the plant should operate for a long time. In practice, many start-ups and shut-downs occurred, during which the noise production is higher than during normal operation. The predicted overall sound power level of 98 dB(A) is still exceeded, but this causes no problem. The actual overall value has not yet been measured.

The single shaft **gasturbine, steamturbine and generator** are placed inside a building. Much attention was paid to the noise production of these installations, such as a special cladding around the gasturbine, silencers around the gascombustion chambers, an enclosure around the steamturbine and various smaller measures. The walls are sound absorbing. The overall reverberant sound pressure level is about 86 dB(A) (ref. 20 µPa).
The waste heat boiler is insulated with a resulting sound pressure level around 60 dB(A) at 1 meter from the surface. The exhaust silencer is designed to meet a sound power level of 91 dB(A) at the stacktop.

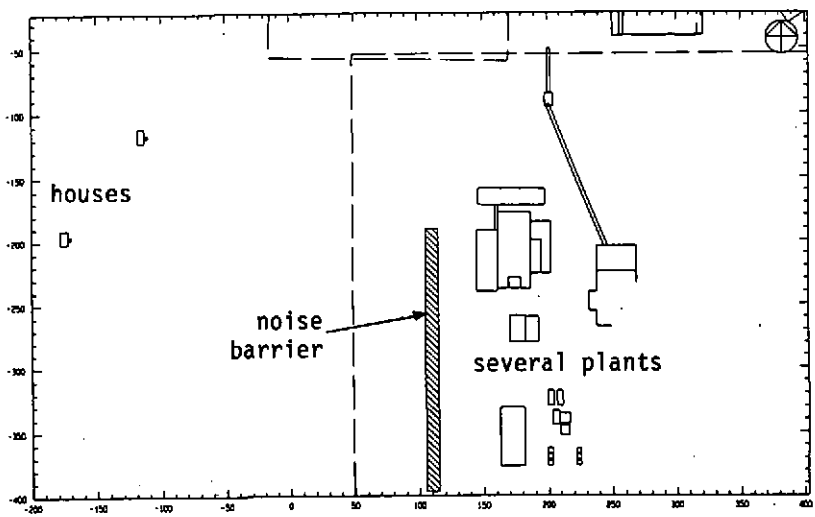

Fig. 2: Noise transfer model: power plant and neighbouring houses

4. IMMISSION MEASUREMENTS

Noise level measurements were independently carried out by the Authorities and by *dgmr*. Both concluded that the noise immission is within the permit. To further reduce the noise at the neighbouring houses a three meter high earth barrier was made with a wooden screen on top (figure 2). Through this noise sources at ground level are shielded. The overall effect at the houses is about 0.5 to 1 dB. The resulting noise level is 48 dB(A) at the most relevant location (49 dB(A) allowable during night-time).

5. SOME SPECIAL ACOUSTIC PROBLEMS

During the project, a few special acoustic problems occurred, such as:

- The step-up transformer produced more noise than expected. To reduce and shield the tonal sound, a wall of low frequency absorbing blocks was placed in front of the transformer;
- The incinerator unit produced a low frequent noise due to resonances inside the combustion chamber. This could be reduced by injecting air directly into this chamber. The optimum amount of air depended strongly on the combustion process. This method could only work with a direct feedback between the produced noise and the injected air quantity. Although this method was technically possible, it was decided to solve this problem by installing a silencer before the exhaust pipe;

6. SOME FINAL REMARKS

When all plant sections were completed, it was decided to install a permanent noise measurement system with a warning facility in the main control room. This gives the operating staff some kind of feedback on the actual outdoor noise production. This system has proved to be very useful, and can be used to correct noisy operations.

For the external acoustic consultant it is important to be involved during the whole process of design, vendor specifications and guarantees, construction and start-up of the plant. Especially the comparison of demanded specifications and guaranteed values is important. In a later phase of the project, lack of this comparison may lead to a lot of discussions and unpleasant surprises. Incidental noise during initial commissioning and normal plant start-up and shut-down must also be taken into account. Some "acoustic space" should be reserved for unexpected noise sources and for ageing effects of equipment also.

References:

[1] Guide for Measuring and Calculating Industrial Noise, IL-HR-13-01 (1981)
[2] Snellink, G: Noise and pulsations from combustion inside furnaces, Gas, 12-69