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NOISE CONTROL DESIGN FOR A STEELWORKS PLANT

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INTRODUCTION

Hitherto, a high noise level has been an integral part of the production process in heavy industries like steelworks, shipyards etc. Some years ago when SSAB (Swedish Steel Corp.) started the planning of a radical modernization of their Domnarvet plant, we were however asked to present: what can be done to improve occupational noise levels in the new production premises.

The acoustical planning has included several parts of a plant where steel sheet is produced. Here we limit the description to the noise reduction work for a pickle-line. Coils containing medium-gauge (thickness 1.2-6 mm) steel sheet are welded together to give a continous strip running through a process where oxide scale and rust is removed using a mechanical and chemical treatment.

NOISE SOURCES

Typically the noise generation in heavy industries is caused by very large vibration and impact forces appearing in the process and by airborne sound from fans, electric motors, hydraulic pumps, air nozzles etc. A block diagram of the pickle-line is seen in figure 1. The principal parts and main noise sources are marked on the layout.

In order to obtain a clear view of noise levels and the mechanism of noise generation in existing pickle-lines, several plants in Europe were studied. A compilation of average noise levels is given in figure 1, next page.

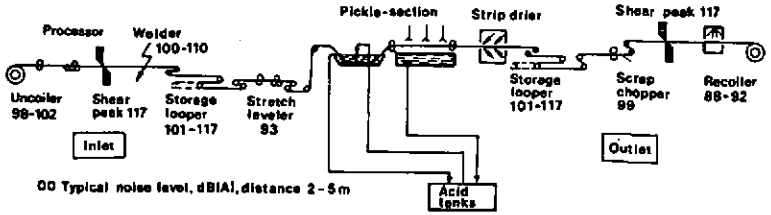


Fig.1 Diagram over a pickle line with the most severe noise sources

Main sources

Storage looper. The main source was found to be the storage looper: an open steel-profile structure containing rolls (driving and supporting) carrying the steel strip running at a very high speed (max 600 m/min). Due to the positioning of a trolley this buffer may contain several hundred meters length of the strip. The looper strip length, irregularities in the steel sheet, etc determine the noise generation. At 2 m distance, levels in the range 101-117 dB(A) were measured.

Table in entry (and exit). Handling of coils, cutting the steel sheet in a shear and feeding the sheet to the welder give rise to equivalent sound levels around 100-105 dB(A) at 2-4 m distance. Similar conditions rule at the exit.

Flush butt welder. Mechanical impacts when the sheet is clamped and cleaning with air nozzles are main sources. Typical noise levels here are also 100-110 dB(A).

Scrap chopper. The width of the strip is adjusted by edge-cutting in rotating shears. Chopping the edge-trim strip into small pieces is very noisy, equivalent sound level is around 100 dB(A).

PLANNING THE NEW PLANT

It was obvious from the studies in existing plants, that a systematic program including all types of measures had to be established in order to reach considerably lower noise levels. The program contained:
building constructions; machine layout; equipment noise level guarantee/supplementary noise reduction.

Aim for noise levels

Setting out from the studies in other plants and the preliminary layout, expected noise problems were listed. All these problems/causes of noise generation were discussed with the project management and with the tenderers (for equipment deliveries) and realistic measures were determined. The noise reduction of these specific measures was esti-

mated. In the same way, possible and realistic constructions were chosen for the building, in order to ensure low sound propagation. Descriptive basic data were fed into a computer which made a prediction of the noise levels in the pickle-line hall (cf figure 2). This calculation characterizes the noise level aim for the plant.

Building constructions

The dimensions of the pickle-line hall is 285x36 m, height 18 m. The floor is 400 mm concrete cast directly on a very homogeneous ground and it therefore offers a good fundament for vibrating equipment. In spite of large dimensions and height of the hall, an absorbing ceiling showed to be an efficient solution also from the economical point of view. To the entire corrugated sheet-metal roof is mounted 50 mm factory painted mineral wool slabs with about 50% coverage. Also one short wall and both long walls at the entry and outlet side of the line are sound absorbing (50 mm mineral wall protected by perforated sheet metal; hollow brick at the bottom).

Operators' cabins were purchased as prefabricated units with noise reduction guarantee. The demand was based upon the predicted sound levels and an inside level not exceeding 55 dB(A). The cabins are mounted on vibration isolators.

Machinery layout and noise control

Storage looper. Because the acid tanks for the chemical process could be located on top of the concrete walls in a complete enclosure for the looper, this was a feasible and efficient solution. There are large doors in the concrete walls and cranes inside, making it possible to replace rolls. Doors are purchased with a sound insulation guarantee due to specifications. In order to minimize sound leakage at the openings for the strip, the inlet and outlet zones are at a length of 15 m sound absorbing using 50 mm mineral wool in the ceiling and on the walls.

Tables. Guide rolls on the tables in entry and exit resp. were provided with polyamid coating to reduce impact noise. Fewer rolls with a larger spacing than normal were installed in order to minimize the number of contact points between strip and rolls.

Processor. The machinery construction could not be changed so an enclosure was discussed but rejected due to maintenance and operation disturbances. Some smaller, internal screens and sound absorbing surfaces were, however, added to the machine construction. A suction hood was also designed to give a noise screen effect.

Welding machine. In the flush butt welder the strongest noise sources are the air cleaning nozzles and pneumatic valves for clamping jaws.

Nozzles were exchanged by multihole quieter type and valves were equipped with mufflers. The operator is located in a cabin, purchased with sound insulation guarantee to give an average reduction of 50 dB(A).

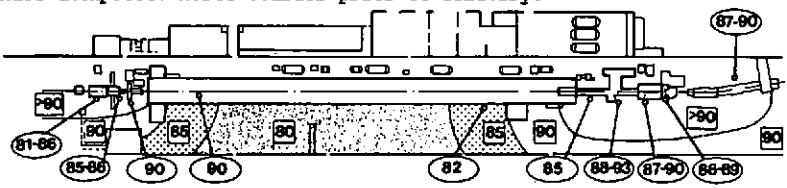
Scrap-chopper. The knives have been reconstructed to give a shear-action (at an angle) instead of a right-angle cutting. The hood is internally sound absorbing and the chute walls have viscous damping (double steel sheet with rubber in between). The scrap is transported on a rubber belt conveyor to a bin, in order to reduce fall height.

Shears incl. chutes. The same principles as for the scrap-chopper were used to reduce impact noise generation.

Equipment noise level guarantee
As mentioned above tenderers were involved in the project at an early stage, which proved to be very important in the discussions on practical solutions for the noise problems.

In the final noise guarantee texts it was specified that SSAB should have the opportunity to make predelivery inspections of the equipment in question, e.g.
- evaluation of technical solutions, selected components etc that affect the noise generation
- measurement of sound levels during testruns at the expenses of the contractor

This clause proved to be an important possibility to find and eliminate unexpected noise sources prior to delivery.



00 Predicted noise level
(00) Guarantee measurements, dB(A), distance 2m. Normal operation.

Fig. 2 Predicted and measured noise levels

RESULTS AND CONCLUSIONS

Compared to older plants, the new SSAB pickle-line is very quiet, which is the quite dominating reaction from the personnel. Some measurement results from the plant in full operation are marked in figure 2 and show that the ambitions to reach low sound levels are satisfied. Zone values and measured levels are L_{eq}.