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NOISE CONTROL FOR A BETTER ENVIRONMENT

Comparison of ISO 9613-2 and CNOSSOS-EU methods in noise modelling of a large industrial plant

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ABSTRACT

Acoustic models of large industrial plants are built using measurement results as input data and subsequent verification of model calculations. The purpose of these calculations is to forecasting noise emissions taking into account new installations, sound power level reduction of selected sources or changes in technology, etc. As far as the input data - sound power level - can be considered as independent of the adopted model, then the measurement verification of model calculation already depends on. Calculations according to ISO 9613-2 applies to sound propagation with wind, while the CNOSSOS-EU model additionally enables calculations in isomorphic conditions. This is a valuable opportunity in terms of verification of the measurement model calculations contrived in all directions around the modelled industrial plant. In the case of the ISO model, such verification is possible in inversion conditions or only on the leeward side and with some limitations, especially in the case of large area industrial plants.

The paper presents the results of model calculations of a large industrial plant (steelworks) carried out according to ISO and CNOSSOS-EU, which were compared with the measurement results at selected control points around the plant

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under different weather conditions. Additional sources of errors in industrial noise modelling were indicated, independent of the adopted model - sound power levels of sources, determined on the basis of measurements made in in-situ conditions and emission measurements at control points in the case of disturbances from other installations that are not part of the modelled industrial plant.

Keywords: large industrial plant, acoustic maps, noise modelling
I-INCE Classification of Subject Number: 52.5, 76, 81.2

1. INTRODUCTION

The construction of noise models of a large industrial plants "always" was a big challenge, not only in the stage of the model developing itself, but also in the metrological layer - in the preparation phase of input data (determination of sound power level) and in the verification of model calculations. In accordance with Directive 2002/49/EC [1] the industrial noise calculation model for sound propagation should be created according to the ISO 9613-2 [2] algorithm, while the input data can be obtained by different ways. In the case of existing plants input data (sound power levels) is usually acquired in the measurement way. However, it is possible to expand, modernize or build completely new installations in the existing plant. Then the input data can be entered based on the manufacturer's data or a measurement method, but in another place where such objects are already installed. In the absence of both possibilities, the sound power level is estimated, e.g. based on the efficiency, electrical power of the device, technology, etc. or adopted according to catalogue data. Sound power level determination methods even based on the ISO 3746 [3] survey method are extremely difficult to apply mainly due to the lack of the possibility of eliminating the impact of noise from other devices. On the other hand, the sound power levels from catalogue given by device manufacturers can in real assembly conditions significantly vary. The result is frequent cases of overestimation or underestimation of the acoustic power. In a large plant with a large number of noise sources, it can be assumed statistically that these cases compensate, assuming that at no stage is a systematic error made. However, it is not known which power is overestimated, which is underestimated, which is important at the stage of selecting sources to be silenced and determining the necessary reduction of their sound power.

2. ASSUMPTIONS OF NOISE MODELLING METHODS

In the case of the ISO 9613-2 [2] algorithm, it should be remembered that the calculations are generally made for the downwind conditions. While this does not matter for the calculations, the situation is much more difficult from the point of view of measuring verification. In practice, the verification is not possible to carry out in one measurement session when the wind blows in one direction because only in this direction (under given conditions) conditions will be compatible with the model, while ones not compatible for other wind directions. On the other hand, taking measurements on different days (with the proper wind direction) may also correspond to the varied state of the plant's operation. In practice, it is possible to carry out verification measurements in the temperature inversion conditions when conditions of the sound propagation are favourable for all directions, but not fully corresponding to the downwind propagation. Considering the above-mentioned aspects in the existing conditions for the creation

Table 1: Results of model calculations and measurements at selected points around the large industrial plant.

point no.	A-weighted sound pressure level [dB]				
	calculated values			measured values	
	W_I	W_II	W_III	November 2017	May 2018
1	39.8	35.8	39.7	49.6	43.6
2	39.8	36.0	38.8	57.7	44.4
3	34.1	29.9	31.1	—	—
4	36.4	32.1	36.2	46.9	50.5
5	40.7	37.5	38.4	54.6	51.8
6	39.8	35.5	35.5	—	—

and verification of acoustic models of a large industrial plants in many stages mistakes can be made. Despite the "correct" final verification, it is not sure whether for other variants of the plant's operation, including the reduction of sound power level of selected installations or the expansion of other installations, the results of noise emission calculations will correspond to the reality values with assumed uncertainty.

The situation is somewhat better in the case of the CNOSSOS-EU [4] method. This method introduces to the calculation model of the industrial noise propagation the neutral (homogeneous) weather conditions, i.e. windless and no temperature inversion. This approach allows to perform verification measurements in more realistic weather conditions. Of course, there is still the problem of ambiguity in determining the sound power level.

3. RESULTS AND CONCLUSIONS

The model calculations results for one of the large industrial plants in Poland for conditions according to the ISO 9613-2 [2] model, i.e. downwind (Table 1, W_III) and for the CNOSSOS-EU [4] model for homogeneous conditions (Table 1, W_I and W_II) are presented in this work. The plant covers an area of approximately 750 ha where over 200 different noise sources are located. In the case of the modelled plant there was an additional problem appeared in the verification measurements of the calculations in the points, because the measured noise in some points also came from other installations, outside this plant. It seems obvious that in such a situation verification can be effectively carried out only on the basis of points where the noise comes only from the modelled object. However, in reality there are few such points or only concern one side of the plant.

Discrepancies in the calculation results will mainly depend on the dimensions (extent) of the plant and the location of the loudest noise sources, i.e. the distance between the source and the observation point. As shown in Table 1, depending on the weather conditions, the divergence of measurement results may be as much as a dozen decibels (13.3 dB in point 2). In such a situation, it is difficult to indicate these "good" measurement results to verify the model. Therefore, measurement and modelling in conditions of uniform propagation in all directions should be the most advantageous from the point of view of verification of the computational model of a large industrial plant.

More detailed results of calculations showing differences in calculations according to both models and in relation to the measurement results in different weather conditions will be presented at the INTER-NOISE 2019 Conference.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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