The 1:60 scale models have shown reasonable results with the subgram interations, initial time delay gap, and temporal energy ratios. Even extremely crudely built models can yield a significant amount of information especially for unfiltered noise studies.

Table I. Comparison of wide band noise signal at center balcony position.

<table>
<thead>
<tr>
<th>Room</th>
<th>Initial Time Delay</th>
<th>Rise Time 5 dB</th>
<th>Rise Time 3 dB</th>
<th>Rise Decay 160 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototype</td>
<td>0.012 s</td>
<td>0.0186 s</td>
<td>0.0511 s</td>
<td>4.6 dB</td>
</tr>
<tr>
<td>1:10 model</td>
<td>0.011</td>
<td>0.0193</td>
<td>0.0492</td>
<td>6.3</td>
</tr>
<tr>
<td>1:60 model</td>
<td>0.011</td>
<td>0.0183</td>
<td>0.0528</td>
<td>5.0</td>
</tr>
<tr>
<td>1:100 model</td>
<td>0.007</td>
<td>0.0225</td>
<td>0.0565</td>
<td>7.5</td>
</tr>
</tbody>
</table>

REFERENCES


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Computer Program for predicting the Energy Consumption and Operating Costs of Boiler Plants

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KEYWORDS

Boiler Plant, Energy Consumption, Space Heating

ABSTRACT

Designing new boiler plants or renovating existing boiler plants for heating buildings will generally mean that a number of alternatives will have to be evaluated. Careful choosing can result in substantial reductions in costs and/or energy consumption. Since this evaluation procedure is extremely labour-intensive, only a few alternatives are usually considered. The aim was to develop a boiler selection program for analysing rapidly and accurately the energy consumption and operating costs of boiler plants.

The principle of the boiler selection program is based on the calculation of the hourly useful output and the energy consumption of the boiler plant. To do this a theoretical model was included in the boiler selection program, containing the ratios between full-load efficiency, standstill-loss and utilization efficiency. Also included in the boiler selection model is an economic evaluation feature. The program simulates the behaviour of the boiler plant based on output data covering not only the boiler plant to be simulated and economic factor, but also the hourly heat demand and outside temperatures.

The boiler selection program developed has been validated by tests in an existing boiler plant. The discrepancies in energy consumption between the actual measurements and the simulation calculations were between 0.1 and 5.7%. It can be concluded from this that the correlation between reality and simulation is good.
Programme d'Ordinateur pour la prévision de la Consommation d'Energie et des Frais d'Exploitation des Chaufferies

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MOTS CLEFS

Chaufferies, Consommation d'énergie, Chauffage des locaux

SONNIAIRE

La conception de nouvelles chaufferies ou la rénovation de chaufferies existantes destinées au chauffage de bâtiments implique désormais une évaluation de diverses solutions. Un choix judicieux peut se traduire par une réduction substantielle des coûts et/ou de la consommation d'énergie. Comme cette évaluation exige un travail considérable, elle se limite la plupart du temps à quelques solutions. Le but était de développer un programme de sélection de chauffières permettant d'analyser de manière rapide et précise la consommation d'énergie et les coûts des chaufferies.

Le principe du programme de sélection de chauffières repose sur le calcul du rendement et de la consommation horaire de la chaufferie. A cet effet, le programme de sélection de chauffières englobe un modèle théorique prenant en considération la relation entre le rendement à pleine capacité, les pertes à l'arrêt et le rendement d'exploitation. Le modèle de sélection de chauffières comprend également une évaluation économique.

Le programme simule le comportement de la chaufferie à partir des données d'entrée qui, outre les données relatives à la chaufferie à simuler et les données économiques, comprennent la demande de chaleur horaire et la température extérieure.

Le programme de sélection de chauffières ainsi développé est validé par des mesures effectuées sur l'installation existante. Les écarts de consommation d'énergie entre les mesures et les calculs produits par la simulation se situent entre 0,1 et 5,7%.

On peut donc en conclure que la simulation est le reflet exact de la réalité.

1. INTRODUCTION

The design of new boilerplants for space heating and the partial replacement of existing boilerplants, involves a thorough evaluation of a number of alternatives. A good choice may very well lead to a substantial reduction in costs and/or energy consumption. The evaluation procedure, being very time-consuming, is therefore often limited to a few alternative boilerplants. The TNO Boilerselection-program presented here offers an accurate and fast method for the analysis of energyconsumption and costs of boilerplants.

2. THEORY

The basic principle of the Boilerselection-program is the hourly calculation of utilization efficiency and fuelconsumption of the boilerplant. The use of the utilization efficiency \( \eta_u \) instead of the boiler full-load efficiency \( \eta_f \) for energyconsumption calculations, has been introduced by Dittrich, who related the two as follows:

\[
\eta_u = \frac{\eta_f}{(1 + (1/\beta - 1) + q_u)}
\]

where \( \beta \) is the degree of utilization and \( q_u \) is the boiler's standstill-loss. The hourly fuelconsumption \( \Phi_f \) may then be calculated using:

\[
\Phi_f = \frac{P_{max} \times \beta \times 3600}{(H_b \times \eta_u)}
\]

where \( P_{max} \) is the maximum boilerpower (kW) and \( H_b \) is the gross calorific value of the fuel (kJ/kg).

In reality \( \eta_f \) and \( H_b \) are not constant. The standstill-loss of a boiler depends on boilerconstruction, watertemperature, flue-draught, cycle frequency and length of "OFF" period during cycling operation. The boiler full-load efficiency depends on boilerconstruction, watertemperature and burner-control. The degree of utilization depends on total installed power and building heatdemand. In the Boilerselection-program all these and other relevant variables are related in a theoretical model. Beside the analysis of boilerplant-operation, also an economical evaluation forms part of the Boilerselection-program, using the so-called present worth value (P.W.V.) method.
3. COMPUTER PROGRAM

3.1 Input

In theory, a large number of different boiler plant concepts can be designed. Which boiler plant can be analysed by the Boilerselection-program may derive from the input-sheets, presented in fig. 1. By addressing input data only to those variables that are relevant for the boiler plant considered, this plant will be "profiled" in the Boilerselection-program. Besides the plant data, also the hourly results of a (dynamic) building heat load calculation (based for instance on a reference year for weather conditions) must be available for input.

3.2 Calculation Procedure

The calculation procedure of the Boilerselection-program is illustrated by the simplified flow sheet, presented in fig. 2. This calculation is to be executed per hour during the period for which the hourly heat demand is known. At the end of this period the economical evaluation starts, using the calculated energy consumption as an input.

Fig. 1. Input sheets of Boilerselection-program

Fig. 2 Illustration of calculation procedure
3.3 Output

After termination of the calculations, the Boilerselection-program produces data on the following subjects:
Per hour (e.g.): building heat demand (= input), water temperature (per boiler), degree of utilization (per boiler), burner operation (per boiler), fuel consumption (of the plant), utilization efficiency (of the plant).

On the year's basis (e.g.): total building heat demand, boiler plant energy consumption, utilization efficiency, P.M. N. of running costs, pay-back period of investment.

4. VERIFICATION OF THE COMPUTER PROGRAM

The Boilerselection-program has been verified by measurements on an existing boiler plant (475 kW atmospheric boiler), for three different operating conditions. These conditions for the measurements are:
A: constant water temperature (70 °C) and on-off burner control
B: weather dependent water temperature and on-off burner control
C: weather dependent water temperature and High-Low burner control.
Both boiler plant behaviour and fuel consumption have been verified, but also investigations into the boiler plant's properties have been carried out.

4.1 Boiler plant behaviour

How the Boilerselection-program simulates the actual boiler plant behaviour is illustrated in Fig. 3, where various variables are compared for one day of measurement C. The agreement between measurement and simulation is good.

4.2 Fuel consumption

Table 1 shows a comparison between the measured and the calculated boiler plant fuel consumption. Here too the agreement between the two is very good.

Table 1. Results of verification measurements (M) and calculations (C)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Fuelconsump. $m^3$</td>
<td>1392</td>
<td>743</td>
<td>1022</td>
</tr>
<tr>
<td>M Utilization eff. $%$</td>
<td>72.6</td>
<td>71.7</td>
<td>76.9</td>
</tr>
<tr>
<td>C Fuelconsump. $m^3$</td>
<td>1393</td>
<td>748</td>
<td>1079</td>
</tr>
<tr>
<td>C Utilization eff. $%$</td>
<td>72.5</td>
<td>71.2</td>
<td>72.8</td>
</tr>
<tr>
<td>Deviation (C-M) $%$</td>
<td>+ 0.1</td>
<td>+ 0.7</td>
<td>+ 5.7</td>
</tr>
</tbody>
</table>

5. APPLICATION

The application of the Boiler selection-program is illustrated by the analysis of a number of boiler plants with respect to fuel consumption. For the calculations a heat demand and ambient temperature...
pattern was used, that had been derived from the verification measu-
rements. Fig. 4, showing the results of the calculations, also illu-
strates the variety of boilerplants that can be analysed with the
Boilerselection-program.

Fig. 4 Boilerselection-program, results of analysis of various
boilerplants. (V = cascade, D = reverse seq.; A = on-off, H =
high-low, M = modulating; C = convect. eff., K = high eff.; W =
weatherdep., C = constant; SK = butterfly v., "150" = 50% 
overcapacity).

6. CONCLUSIONS

1. The Boilerselection-program is a valuable tool for the design
and evaluation of new boilerplants for space heating in build-
ings.
2. The Boilerselection-program has been verified with measurement
in an existing boilerplant; the agreement between reality and
simulation is good.

ACCURACY DATA OF A STRUCTURE DESIGNED ACCORDING TO THE LIMIT
STATE DESIGN METHOD

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KEYWORDS

limit state design, setting out, measuring-in, accuracy data (collection, calculation,
presentation), positional and dimensional deviations, deformations of load bearing parts

ABSTRACT

In Sweden new regulations - applying the method of limit state design - have been intro-
duced on a voluntary basis and will become compulsory within a few years. On a building
site SIB investigated the geometrical consequences of these regulations in practice. This
field study, which is the first of its kind, consists of two parts:

* Determination of deviations due to e.g. setting out or shuttering
* Determination of deformations of the structure as a possible result of the regulations

In both parts modern surveying techniques were applied for the collecting of a large
number of accuracy data. One of them was the method of "free station points".

The local A, B and C coordinate system on the site was chosen as the reference object for
the measuring-in and the calculation of accuracy data for different items. The coordinate
points were marked by elevated target points in the primary net work around the site.

The advantage of using coordinate systems as reference in this kind of research is, that
from observed positional deviations other deviations, e.g. from verticality, thickness,
eccentricity, slope, straightness of flatness, can easily be derived by the computer.

After storage of the data in the computer, statistical parameters were calculated. The
results were graphically presented in different ways: histograms, circle diagrams or
contour lines giving a direct view over the degree of the flatness of e.g. a floor slab.

The study does thus also give information about alternative uses for the computer in
collecting accuracy data.

It is expected that the application of the new regulations will require more attention
to accuracy than at present. The paper therefore contains examples of some interesting
accuracies and comments e.g. on how these accuracies can easily be improved. Improve-
ments do not necessarily require the use of the latest innovations in measuring - or
production technique, more important simply is a better communication between office
and site.