

Investigations

J. Matusiak, J. Wyciślik, A. Pilarczyk

I-EcoWelding – Internet System of Guidance Supporting Calculations of Welding Fumes Emissions in Welding and Allied Processes

Abstract: The article presents a new tool for environmental analyses concerning pollutant emissions, i.e. the I-EcoWelding software programme. This Internet guidance system is an innovative tool supporting the decision-making related to health and safety in production processes and supporting calculations of pollutant emissions into work environment during welding and allied processes. The Internet guidance system helps determine emissions and compositions of welding fumes during fusion welding, resistance welding, vibration welding of thermoplastics, brazing as well as thermal gas and plasma cutting. In addition, the system enables calculating emissions in relation to the entire welding production of a given company, taking into consideration the duration of a technological process or the declared weight of filler metal used.

Keywords: I-EcoWelding, welding software, welding fumes, pollutant emissions

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The welding sector in Poland provides employment for thousands of fusion welders, brazers, pressure welders, welding machine operators, specialists in production, control and monitoring in machine-building, ship-building, automotive and aviation industries as well as in electrical engineering and civil engineering. The use of welding processes requires maintaining special conditions of industrial health and safety. Welding processes entail numerous chemical and physical hazards. For this reason, there has been continuous demand for information, hints and recommendations concerning

harmful pollutant emissions accompanying welding processes, the effect of these pollutants on worker health and the possible optimisation of technological processes in terms of pollutant emission reductions. Both welding coordination as well as industrial health and safety services have been emphasizing the importance of the necessity for solving problems involving the protection of worker health during welding processes.

For several years, within the confines of European projects, national projects and statutory works, Instytut Spawalnictwa has been involved

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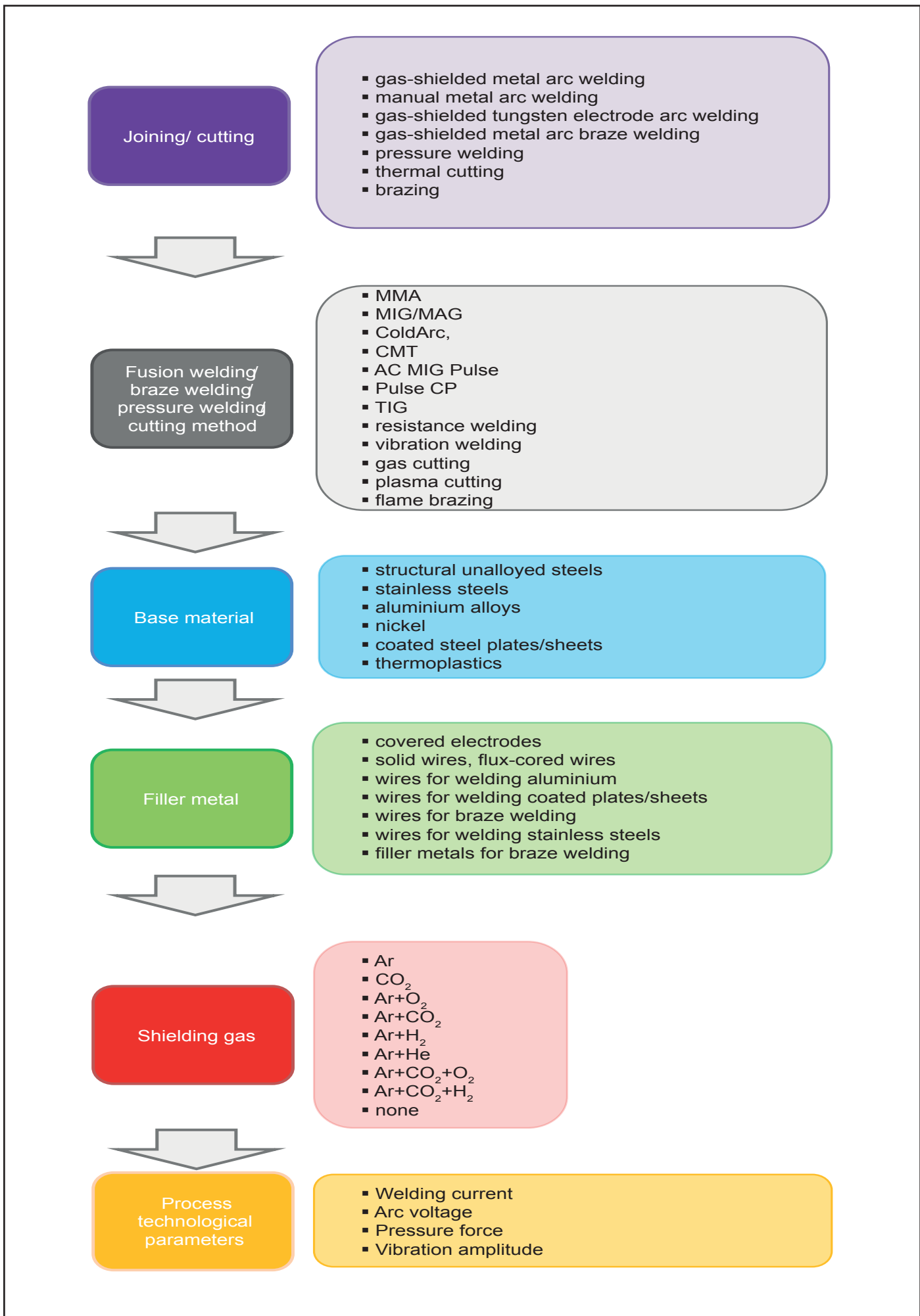


Fig. 1. Scheme presenting the sequence of data search in the system

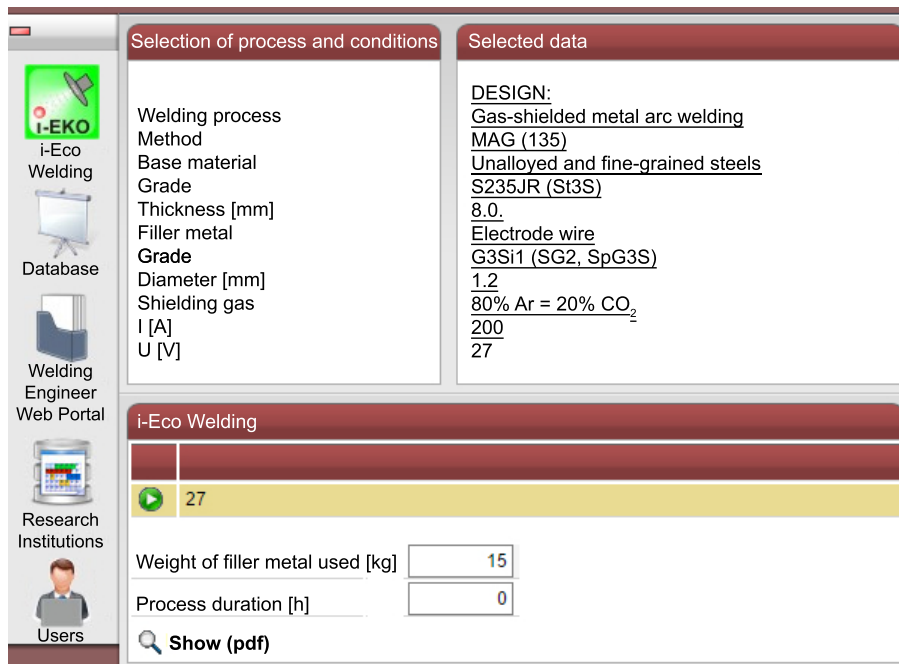


Fig. 2. Screen after entering input data

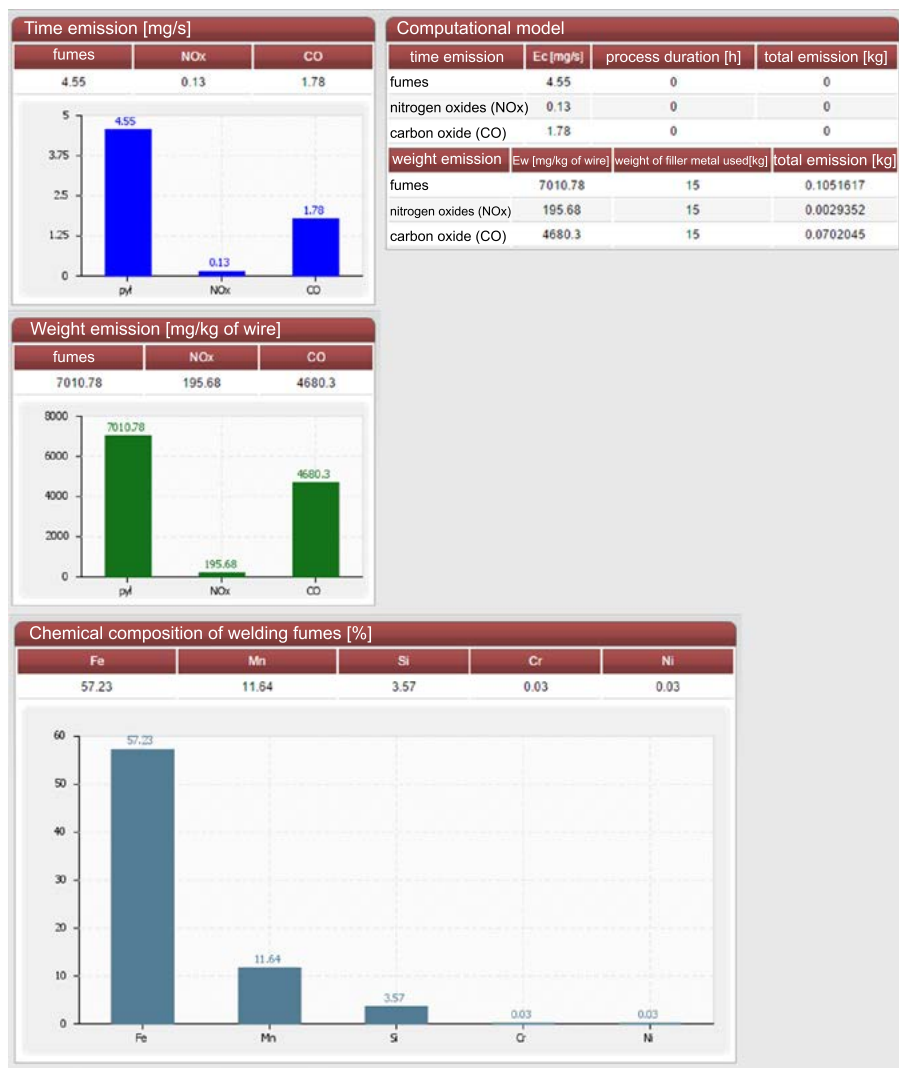


Fig. 3. Screen with results related to gas-shielded metal arc welding –MAG, filler metal wire grade G3Si1, shielding gas 80% Ar + 20% CO₂

in research dedicated to the influence of welding technological and material conditions of welding and allied processes on emissions of welding fumes into work environment. The research has involved tests concerning new joining methods as well as new base materials and filler metals. Results of research works, in the form of fumes emission factors, were disseminated via catalogues concerning characteristics of materials as regards pollutant emissions, single emission sheets related to individual joining procedures, publications in various magazines and, last but not least, in the form of a software programme named Eko-Spawanie (Eco-Welding). This software programme, developed in 2004, within the confines of Multi-Annual Programme (MAP) *Adaptation of work conditions in Poland to standards in the European Union* is dedicated to determining pollutant emissions accompanying MMA, MIG/MAG and TIG welding.

The development and improvement of welding methods as well as the growing awareness concerning hazards in the work environment of companies making welded structures and products have imposed the necessity of providing the welding engineering sector with a new tool for performing environmental analysis focused on pollutant emissions. This new tool is the Internet guidance system

i-EkoSpawanie (I-EcoWelding) based on databases containing emission factors. The system is an innovative tool supporting decision-making related to health and safety in production processes and supporting calculations of pollutant emissions into a work environment during welding and allied processes. The Internet guidance system helps determining emissions and compositions of welding fumes in traditional welding methods, i.e. MIG/MAG, TIG and MIG/MAG performed using pulsed arc and double pulse, MMAW and welding/braze welding using innovative low-energy arc methods such as CMT, ColdArc, STT, AC Pulse and ColdProcess. The system also includes databases of emission factors related to resistance welding, the vibration welding of plastics, brazing as well as thermal gas and plasma cutting processes. The system also enables calculating emissions in relation to the entire welding production of a given company, taking into consideration the duration of a technological process or the declared weight of filler metal used.

The target group of the guidance system includes companies using welding processes in their production, institutions calculating environmental fees in accordance with the Environmental Protection Law and labour inspections. In addition, the system can be used by designer bureaus or companies designing or providing ventilation systems for welding processes.

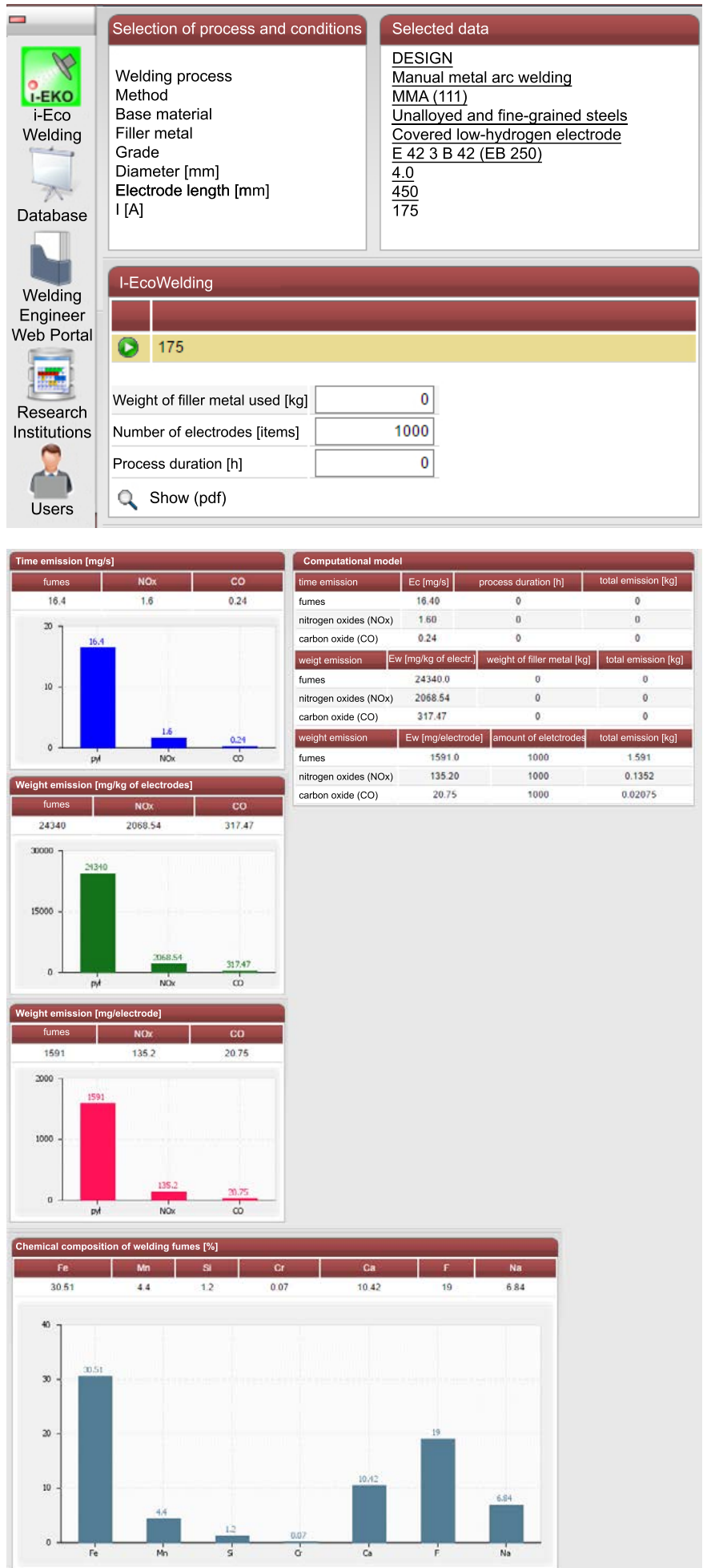


Fig. 4. Screen with results following the selection of MMA welding and covered electrode grade EB 250

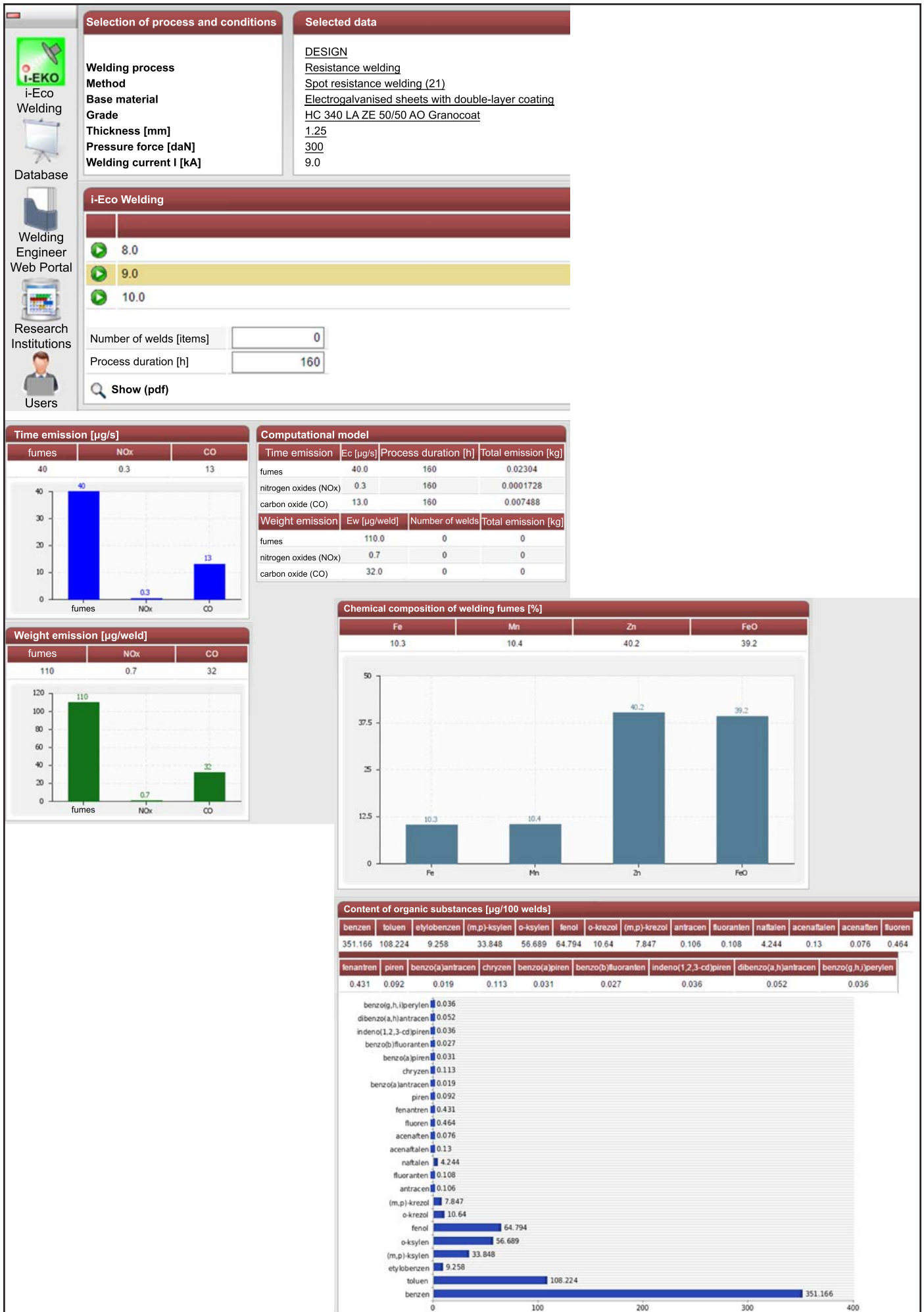



Fig. 5. Screen with results following the selection of resistance welding process

 INSTYTUT SPAWALNICTWA 44-100 Gliwice, ul. Bł. Czesława 16-18 Department of Resistance and Friction Welding and Environmental Engineering	
I-ECOWELDING PROGRAMME SOFTWARE	
POLLUTANT EMISSION DATA SHEET	
PROGRAMME USER DATA	
Company name	Instytut Spawalnictwa
Address	ul. Bł. Czesława 16-18, 44-100 Gliwice
NIP (Taxpayer ID Number)	631-010-22-58
User name	Joanna Wycislik
Sheet generation date	2016-04-29
EMISSION OF WELDING FUMES AND GASES	
Welding process	Flame brazing
Method/ name	Flame brazing (912)
Base material	High-alloy steels; copper and its alloys; nickel and its alloys
Filler metal	Flux-cored silver brazing metal
Grade	AG 203 (PR-LS 45)
Diameter	1,8
Rod length	450
DATA FOR TOTAL EMISSION CALCULATION	
Process duration [h]	160
Weight of filler metal used [kg]	0
Number of rods	0

COMPUTATIONAL MODULE			
Time emission	Ec [mg/s]	Process duration [h]	Total emission [kg]
welding fumes	10.52	160	6.05952
nitrogen oxides (NOx)	3.00	160	1.728
carbon oxide (CO)	0.44	160	0.25344
Weight emission	Ew [mg/kg of brazing metal]	Weight of filler metal used [kg]	Total emission [kg]
welding fumes	38563.70	0	0
nitrogen oxides (NOx)	10679.70	0	0
carbon oxide (CO)	1569.60	0	0
Weight emission	Ew [mg/rod of brazing metal]	Number of rods	Total emission [kg]
welding fumes	250.20	0	0
nitrogen oxides (NOx)	67.11	0	0
carbon oxide (CO)	9.87	0	0

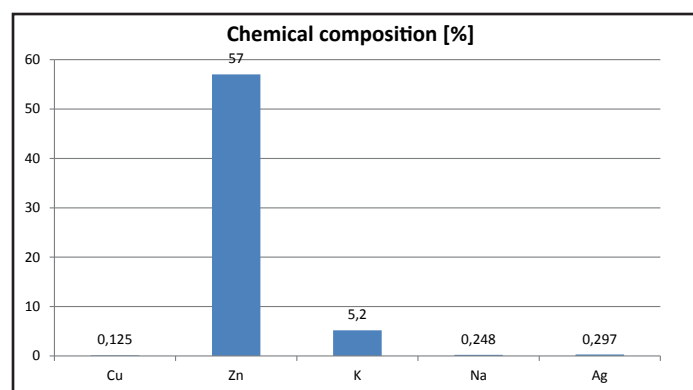
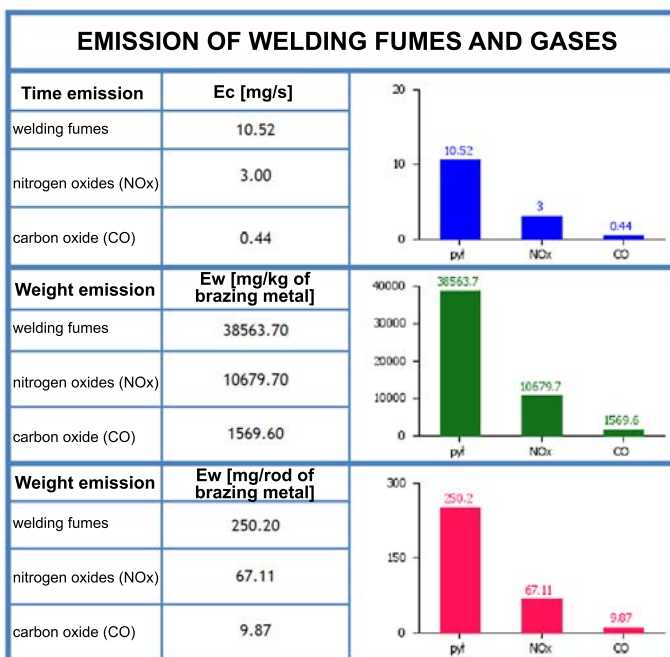


Fig. 6. Pollutant emission data sheet for the flame brazing using silver brazing metal AG 203

Description of I-EcoWelding

The guidance system i-EkoSpawanie (I-EcoWelding) has been made available on the Internet Welding Platform and provides the possibility of the on-line use of knowledge and results of tests concerning pollutant emissions accompanying welding processes as well as makes it possible to determine emission factors of selected fusion welding, braze welding,

pressure welding, brazing and cutting methods in relation to selected structural materials and filler metals. The start-up screen of the I-EcoWelding system contains all welding and allied processes along with pollutant emission-related data. The user starts designing their calculations using the above named screen. The selection of a joining process option is automatically followed by moving on to the selection of

a joining method. Further steps are concerned with types, grades and thicknesses of base materials, and then, types and grades of filler metals and technological conditions appropriate for related joining or cutting processes. The scheme presenting the sequence of data search in the system is presented in Figure 1.

A selected joining process, method, and material-technological conditions are saved in the dedicated window *Selected data: design* (Fig. 2). The subsequent step involves the use of a computational model determining total emissions. The entering of data related to the duration of a process or the weight of filler metal used is followed by the display of a screen presenting all information related to pollutant emissions. Figure 3 presents the screen with results concerning the MAG welding of unalloyed steel sheets/plates using filler metal wire grade G3Si1 and the shielding gas mixture of 80% Ar + 20% CO₂. The screen presents values of time and weight emissions of welding fumes, nitrogen and carbon oxides as well as the chemical composition of welding fumes. The computational module table provides information concerning total emissions in relation to the declared weight of consumed electrode wire. Exemplary result-related screens of the I-EcoWelding system concerning the MMA welding and the resistance welding of sheets/plates with double protective coatings are presented in Figures 4-5.

For each calculation, the system enables the generation of a *Pollutant Emission Data Sheet*. The sheet is prepared in the PDF format and, as a result, can be saved on a disc and printed out.

An exemplary *Pollutant Emission Data Sheet* is presented in Figure 6.

Summary

The Internet guidance system I-EcoWelding is dedicated to determining emissions of fumes generated during welding and allied processes. In its databases, the system contains results of research performed at Instytut Spawalnictwa and concerning emissions and chemical compositions of pollutants emitted to a work environment during various joining and cutting processes. In comparison with the already existing ECO-Welding software programme, the I-EcoWelding system provides the possibility of updating data directly following the completion of successive research works. The system also features a computational module enabling the determination of the total emission of pollutants. The system structure allows its continuous development and the addition of new information using the administrator interface.

The I-EcoWelding system is available on the Internet Welding Platform and is addressed at a variety of companies using welding processes in production. Users can access the system on using their individual login and password.

References

- [1] Matusiak J., Wyciślik J., Pilarczyk A.: *Opracowanie internetowego systemu doradczego wspomagającego określanie emisji zanieczyszczeń przy spawaniu i procesach pokrewnych*. Instytut Spawalnictwa Research Work no. Ma-40 (ST 342), Gliwice 2015