7th Steering Committee Meeting, Lisbon, November 27th and 28th 2008

WP2 "Welding Fumes"

Economically welding in a healthy way

Contract No: COLL-CT-2005-516336

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Work package leader WP2

IIS - Istituto Italiano della Saldatura
Creato da PWR - Public Web Relations

Sixth Framework Programme

SMEs

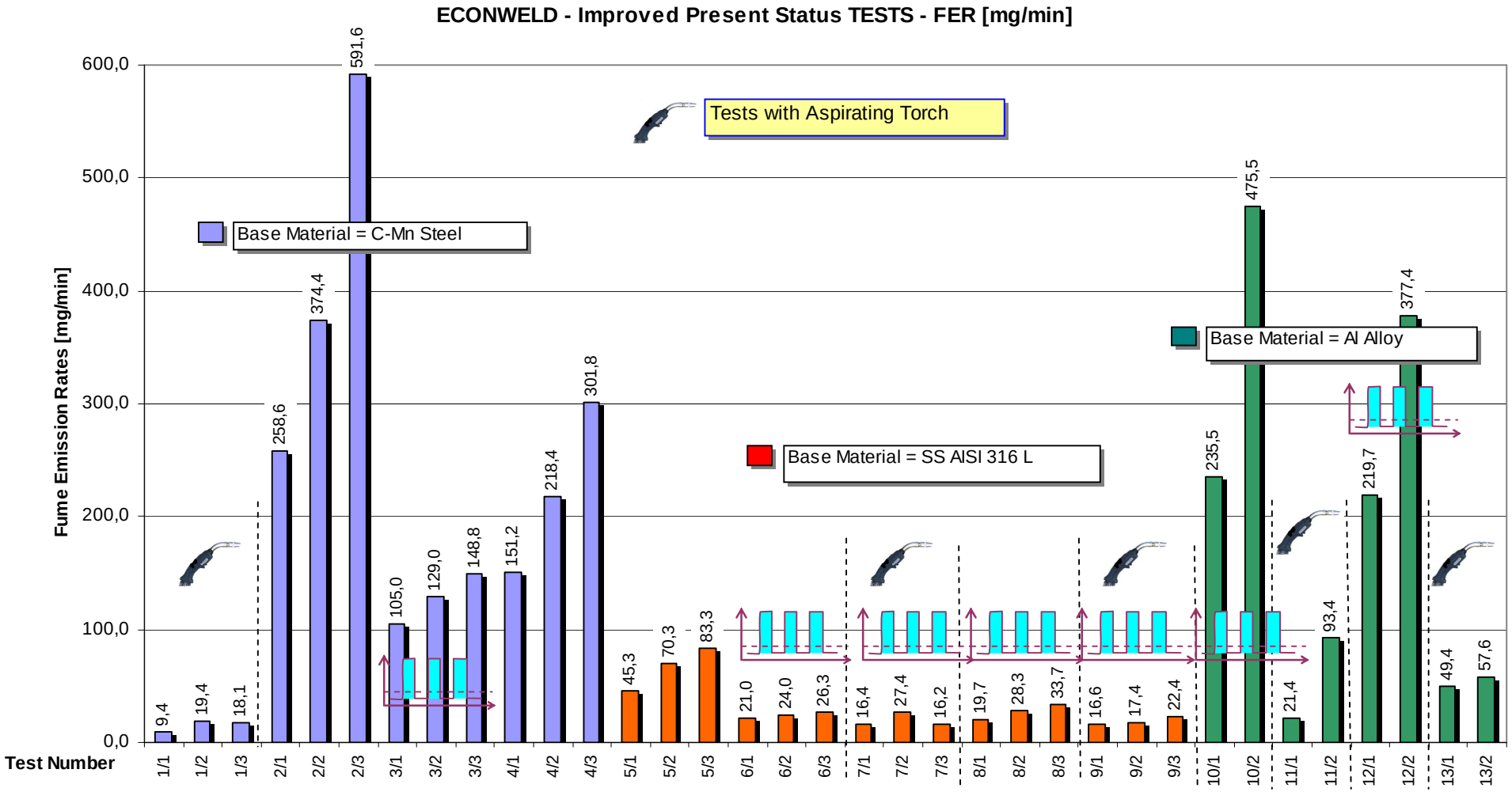
Status of IPS measurements

- **IPS Measurements have been executed subsequently to the activity carried on in the Del D 3.6 - PS Measurements**
- **Tests execution was split up among the three RTD performing partners: IIS - IS - IST**
- **In the IPS measurements it was made use of some innovative methods and tools to reduce welding fume at the source; i.e. new kinds of consumables: "green wires" and ternary mixtures, pulsed waveforms (CDP), aspiring torch.**
- **By means of the execution of the IPS measurements it was possible to prepare the following two deliverable: DelD2.9 "Report containing solutions to reduce welding fumes at the source" and DelD2.10 "IPS Measurements"**
- **For the execution of the IPS measurements 13 different test conditions have been defined as a result of the combination of the above indicate factors, giving place to 105 welding trials.**

D2.10 - IPS Measurements - test conditions

Base Material	Filler metal	Shielding gas	Current waveform	Welding torch	Executor	Test condition
C-Mn Steel S 355 JR (Fe510)	Normal wire	82% Ar-18% CO_2	Without pulsing	With aspiration (by Aspirmig) 	IIS	1
	Green wire	82% Ar-18% CO2	Without pulsing	Normal type (without aspiration)	IS	2
	Normal wire	Ternary mixture 91% Ar-15% CO_2-4%O_2	Pulsed 	Normal type (without aspiration)	IS	3
	Green wire	Ternary mixture 91% Ar-15% CO_2-4%O_2	Without pulsing	Normal type (without aspiration)	IS	4
Stainless Steel AISI 316L	Normal wire	Ternary mixture 78% Ar-20% CO_2-2%O_2	Without pulsing	Normal type (without aspiration)	IST	5
	Normal wire	99% Ar-1% O_2	Pulsed 	Normal type (without aspiration)	IST	6
	Normal wire	99% Ar-1% O_2	Pulsed 	With aspiration (by Aspirmig) 	IIS	7
	Normal wire	97,5% Ar-2,5% CO_2	Pulsed 	Normal type (without aspiration)	IST	8
	Normal wire	97,5% Ar-2,5% CO_2	Pulsed 	With aspiration (by Aspirmig) 	IIS	9
Aluminium Alloy EN AW 5083	Normal wire	99,99% Ar	Pulsed 	Normal type (without aspiration)	IIS	10
	Normal wire	99,99% Ar	Without pulsing	With aspiration (by Aspirmig) 	IIS	11
Aluminium Alloy EN AW 6082	Normal wire	99,99% Ar	Pulsed 	Normal type (without aspiration)	IIS	12
	Normal wire	99,99% Ar	Without pulsing	With aspiration (by Aspirmig) 	IIS	13

D2.10 - IPS Measurements - test results: FER [mg/min]



Formula for the calculation of the FGR [mg/Kg] (valid for solid wires only)

Calculation of the Fume Generation Rates FGR [mg/ kg filler metal deposit]

$$FGR_{fume} = M_{fume} / M_{filler\ metal},\ mg/kg \quad \text{(accuracy 0,01 mg/kg deposit)}$$

where:

M_{fume} – mass of fume, mg (accuracy 0,1 mg)
$M_{filler\ metal}$ – mass of filler metal- deposit, kg (accuracy 0,001 kg)

The calculation of the mass of the deposited metal may be done according to the formula:

$$M_{filler\ metal} = V_{wire} \cdot \gamma \cdot 10^{-3},\ kg \quad \text{(accuracy 0,001 kg)}$$

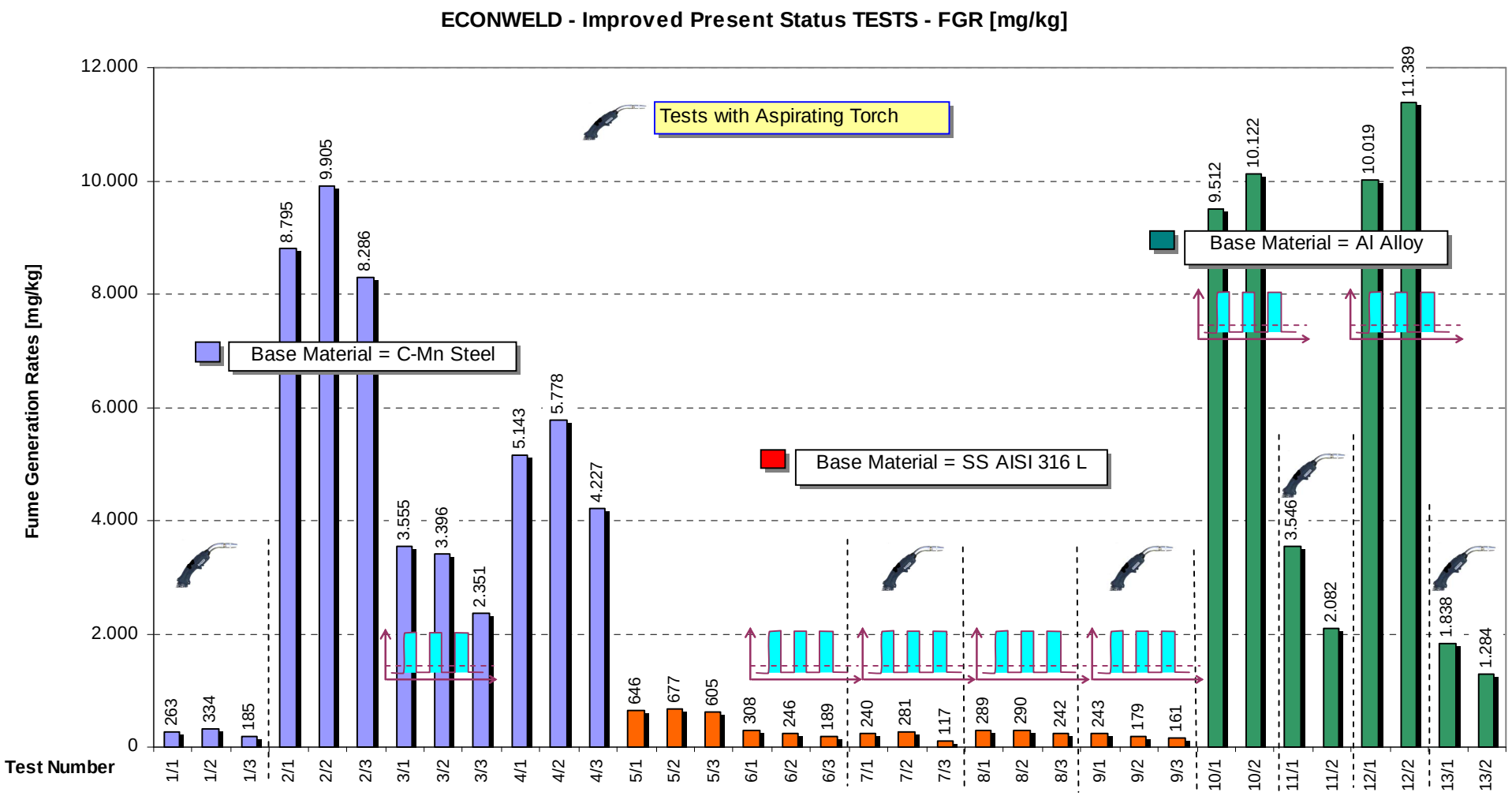
where:

$M_{filler\ metal}$ – mass of filler metal- deposit, kg
V_{wire} – volume of wire (*filler metal used in test*), dcm^3 ($0,01\ dcm^3$)
γ - weight by volume, kg/dm^3

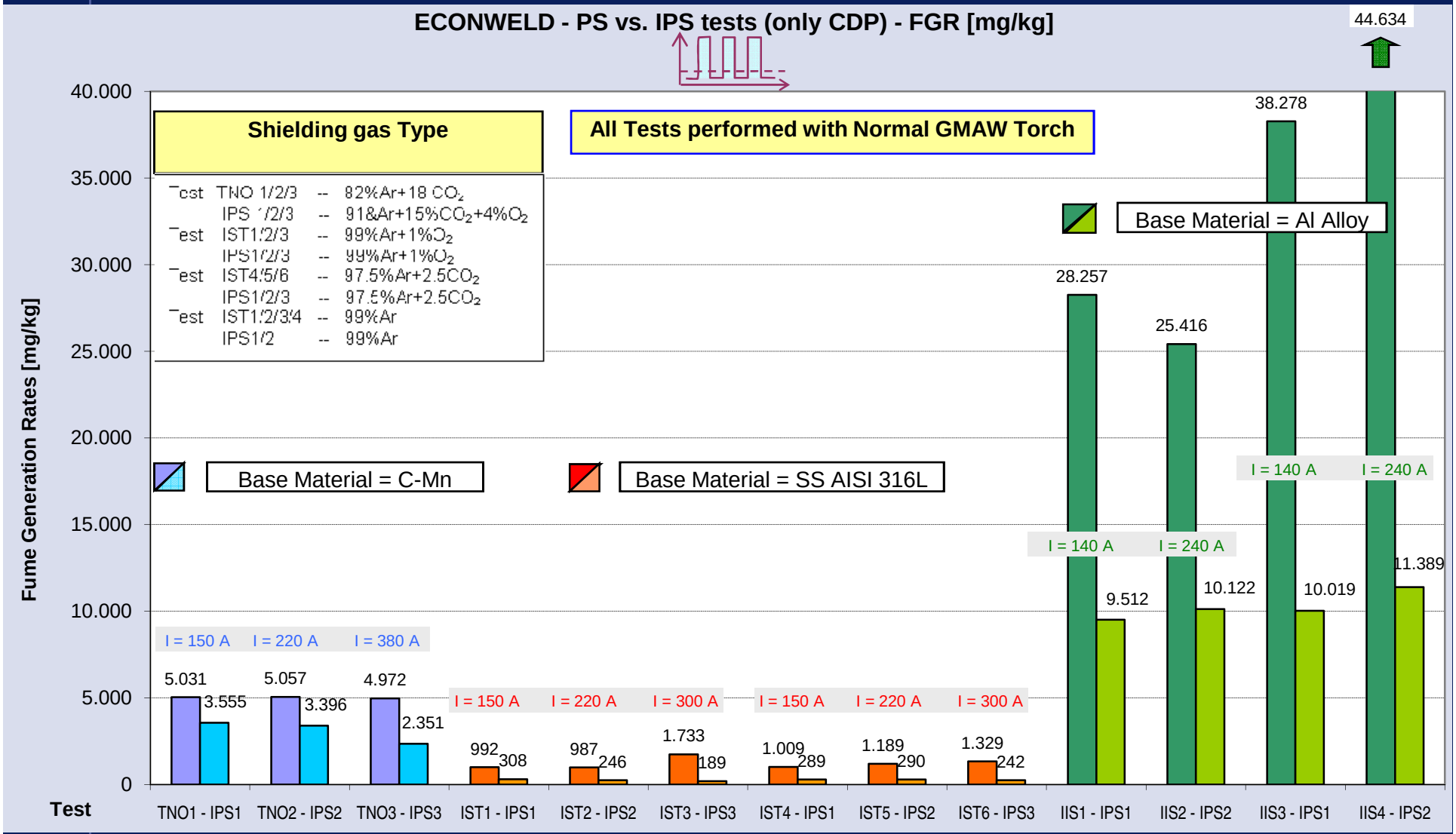
$$V_{wire} = \frac{\pi d^2}{4} \cdot v \cdot t \cdot 10^{-3},\ dcm^3$$

d – diameter of wire, mm (accuracy 0,1 mm)
v – speed wire, m/s (accuracy 0,01 m/s)
t – time of test (*time of welding*), s

D2.10 - IPS Measurements - test results: FGR [mg/Kg]

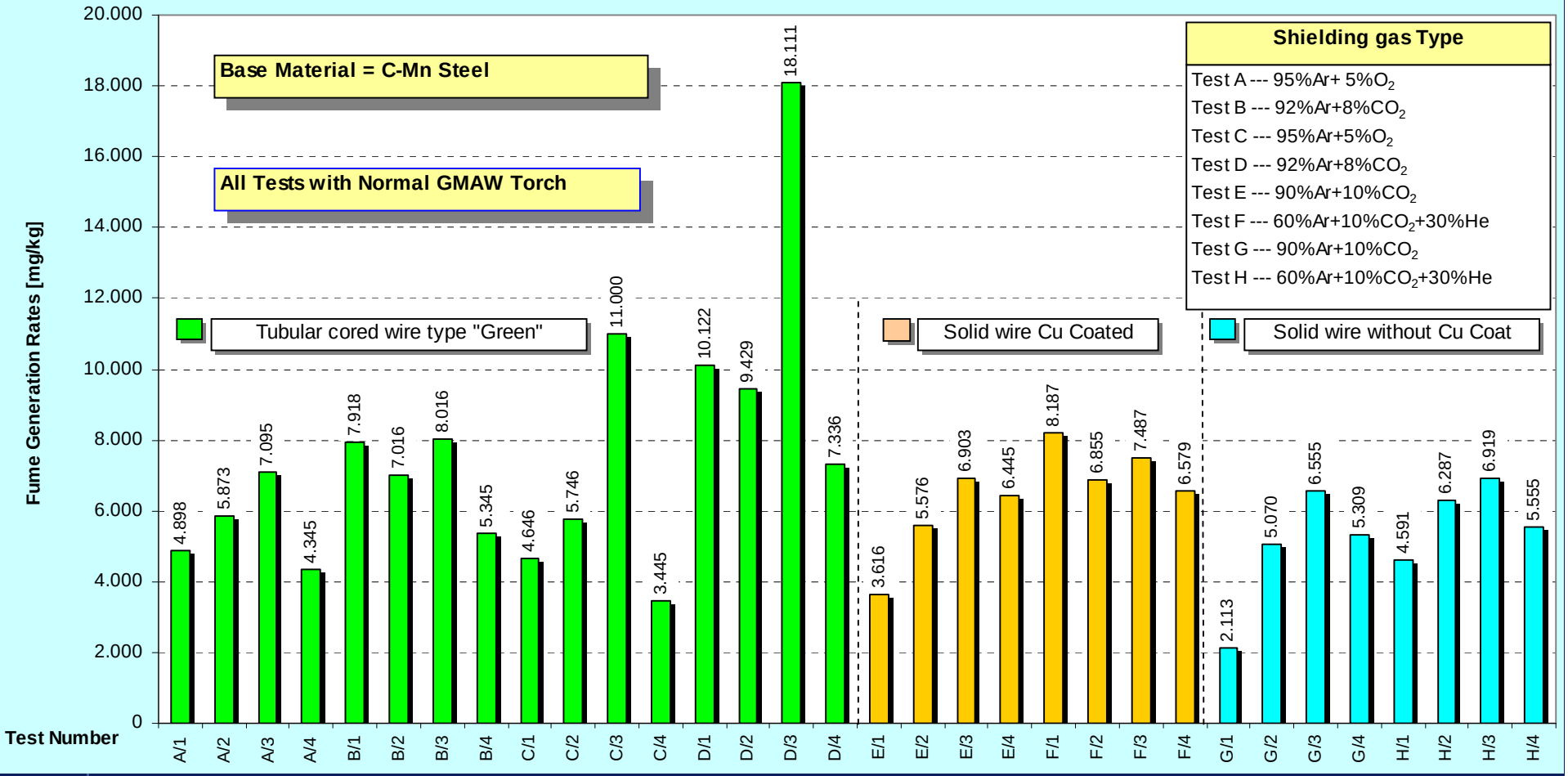


D2.10 - IPS Measurements - PS vs. IPS (CDP only)

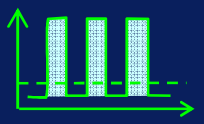


D2.10 - IPS Measurements - additional tests performed by IS

FGR values [mg/Kg] obtained by the combination of different kinds of innovative wires and shielding gas mixtures



Employ of CDP technique



- The cold double pulse technique is greatly suitable to reduce FGR by itself alone
- This positive effect is more pronounced for the inox stainless steel and for the Al Alloys, but it is also noticeable for the C-Mn steel
- For the stainless steel the FGR decrease is respectively 3, 4 and 10 times at the current values of 150, 220 and 300 Ampere, with mixture 99% Ar-1% O2. When employing the mixture 97,5% Ar-2,5% CO2 the reduction ratio is more constant and pair to ab. 4÷5
- For the Al alloyes the FGR reduces 4 times on the material Al6082.
  The reduction is a little lower (2,5÷3 times) on the alloy Al5083
- For the C-Mn steel the FGR reduction ranges from 1,4 to 2 times, according to the situations

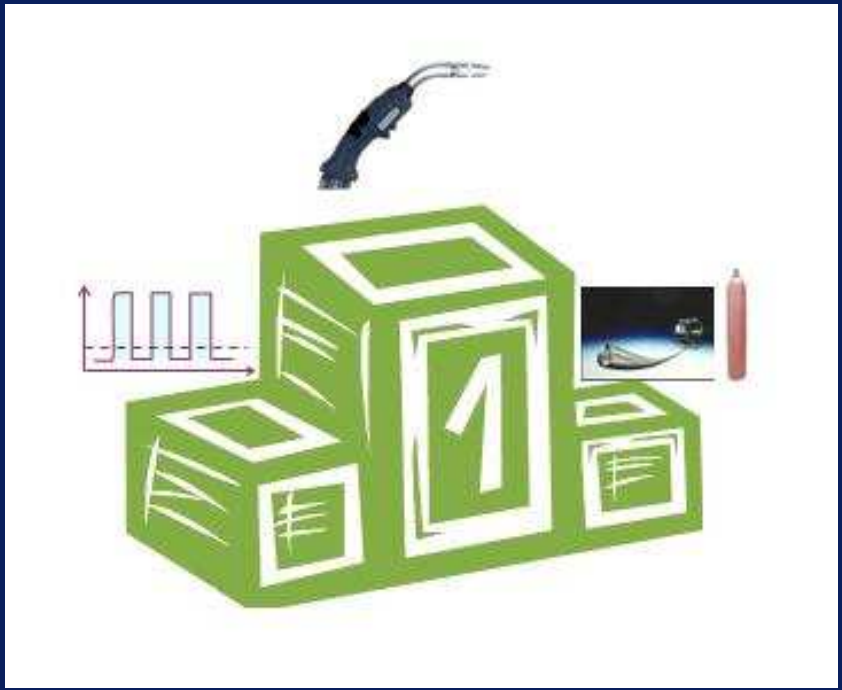
Employ of innovative filler wires and shielding gas mixtures

- the combination between wire (green i.e: flux cored, or solid with or without Cu in the cover) and shielding gas mixture (binary with different contents of active gas CO_2 or O_2, or ternary) may be positive
- the positive effect of the green wires, in terms of FGR reduction, is stronger at the higher value of welding current (300 A) and it is reasonable to expect that they might further be reduced with a current increase
- the green wires behave better then solid wires particularly at the higher current values (300 A). Tests A4 and C4 show better results than test E4, F4 and G4, H4

Employ of the aspiring torch

- The use of the aspiring torch is by far the most effective factor in determining the fume emission reduction
- For the C-Mn steel the FGR decrease ranges from 27 to 15 times at the current values of respectively 380 A and 220 A
- For the Al Alloys the FGR decrease is pair to 35 times for the 6082 Alloy at the current value of 240 A and 8 times for the 5083 Alloy at the current value of 140 A
- For the AISI316L stainless steel the FGR decrease ranges from 15 to 3,5 times at the current values of respectively 380 A and 220 A, when utilizing the shielding mixture 99%Ar-1%O_2 . When utilizing the shielding mixture 97,5%Ar-2,5%CO_2 the reductions obtainable are in an intermediate range.

Ranking of solutions to reduce the FER at the source



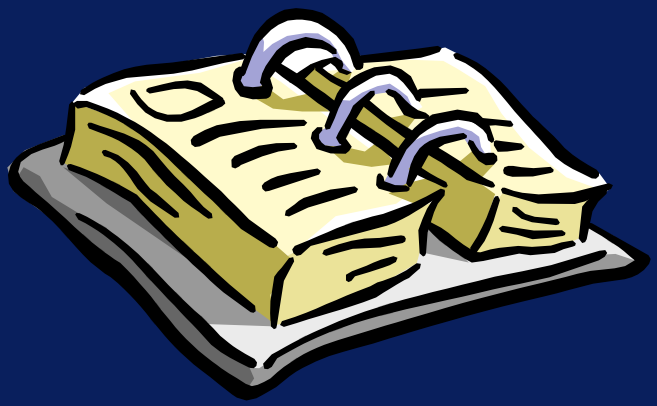
1) Aspiring torch (ab. 35 times on Al alloy and 27 times on C-Mn steel)
2) Pulsed wave technique (CDP) (ab. 10 times on inox steel)
3) Innovative kinds of consumables (green wires + shielding mixtures) [ab. 1,5 times (70%) on C-Mn steel]

Work to be done in Work package 2 : M39-M42

Del.	Description	PM	Start	End	Del. Date
2.1	Intermediate report on progress in developing a flexible, automatically moving exhaust arm	8	25	26	14
2.2	Intermediate report on progress on reducing the emission at the source	7	4	11	11
2.3	Design of lightweight fume extracting welding torch	10,5	4	16	15
2.4	Design of an automatically moving exhaust arm, following the welder	4,1	29	31	18
2.5	Guidelines on optimal ventilation (background and foreground) of the shop floor	3,2	29	31	16
2.6	PS measurements	0,75	5	20	24
2.7	Prototype of lightweight fume extracting welding torch	16,5	18	18	24
2.8	Report on possibilities for new (European) legislation	1	35	**41**	21
2.9	Report containing solutions to reduce welding fumes at the source	21,2	31	38	28
2.10	IPS measurements	0,75	25	**39**	28

D2.8 - Report on possibilities for new European legislation

- **This deliverable was originally assigned to TNO and now taken in charge by EWF**



⇒ Proposal : it may be worthwile to prepare this report after the completion of the following two deliverables D2.9 and D2.10 and after this subject will be discussed in the technical Committees of EWF

- **A possible argument to be considered is an amendment of the European standard EN ISO 15001-1 in view of considering the FGR instead of the FER, in such a way to make it possible also the evaluation of the green (cored) wires**

D2.8 - Report on possibilities for new European legislation

- A mention must be made concerning this specific deliverable, which has been agreed to be the responsibility of EWF
- It is our view that the best way to undertake this will be to provide specific EWF and IIW members, dealing with Health & Safety with the outcomes of the Project
- The meeting that was organized with the IIW Commission VIII in last April 2008 was a good example of this, - to be continued in July 2009
- By addressing the EWF members involved in Health & Safety issues, real possibilities exist of incorporating Econweld achievements into new EU standards – to be done in January 2009 and May 2009

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