MEANING AND IMPORTANCE OF ISO 14175 - WELDING CONSUMABLES - GASES AND GAS MIXTURES FOR FUSION WELDING AND ALLIED PROCESSES

ZNAČENJE I VAŽNOST NORME ISO 14175 – DODATNI MATERIJALI ZA ZAVARIVANJE – PLINOVI I MJEŠAVINE PLINOVA ZA ZAVARIVANJE TALJENJEM I SRODNE POSTUPKE

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Ključne riječi: Brodogradnja, dodatni materijali za zavarivanje, žica za zavarivanje, dozvole, specifikacija postupka zavarivanja, kvalifikacija zavarivača, zakonska obaveza

Key words: Ship building, welding consumables, welding wire, approval, welding procedure specification, welders qualification, bound by law

Sažetak: Norme nisu automatski propisane zakonom. No u područjima u kojima postoji obaveza ili nakon spominjanja ili postavljanja u ugovor ili narudžbu, one su obavezne i moraju se uzeti u obzir. Ovakva situacija je vrlo česta u brodogradnji. Jedan od najvažnijih proizvodnih procesa u brodogradnji je zavarivanje, a jedna od važnijih normi vezanih uz zavarivanje je ISO 14175 koja je važeća u Europi od 2008. Bitno je razumjeti važnosti i značenje normi. Inače nevažna stavka u izradi broda kao što je zaštitni plin može uzrokovati velike probleme. Primjena neprikladnih dodatnih materijala za zavarivanje može uzrokovati vrlo visoke troškove ako se uoči pogreška. Ako se ne uoči pogreška može doći do zakonskih posljedica u slučaju nesreće. Jedan od ovakvih dodatnih materijala za zavarivanje je zaštitni plin. Dostupan je veliki broj zaštitnih plinova, ali kako odabrati pravi? Ovo je cilj norme ISO14175.

Abstract: Standards are not automatically bound by law. But in compulsory approval areas or after mentioned or fixed in a contract or order they are integrated and have to be regarded. Especially in shipbuilding very often we have this situation. One of the most important manufacturing processes in ship building is welding and one of the important standards related to welding is the ISO 14175 which is official in Europe since 2008. It is necessary to understand the importance and the meaning of standards. Otherwise an unimportant part of ship manufacturing like a shielding gas may cause big problems. The use of wrong welding consumables may cause very high costs if you notice this mistake. If you don't notice the mistake it may have legal consequences in case of an accident. One of these welding consumables is the shielding gas. Numerous kinds of shielding gases are available but how to select the right one? This is the aim of the ISO 14175.

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1. INTRODUCTION

In 2008 the German institute of standardisation has transferred the new international standard ISO 14175 into a German standard and since June 2008 it is the official substitute of the EN 439. This will happen to all nations witch belong to the CEN (Comité Européen de Normalisation). These are: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

In this International Standard shielding, backing, process and assist gases are classified and designated. The bases therefore are their chemical properties and metallurgical behaviour. Aim is a correct selection of gases and gas mixtures by the user and the simplification of qualification procedures. The gas purities and mixing tolerances are related to the delivery of the supplier or manufacturer and not to the point of use.

Gases or gas mixtures may be delivered in liquid or gaseous form but meant to be used in the gaseous form.

2. MEANING AND IMPORTANCE OF ISO 14175

The ISO 14175 is an international standard and specifies requirements for the classification and designation of gases and gas mixtures used in fusion welding and allied processes like:

- tungsten arc welding
- gas-shielded metal arc welding
- plasma arc welding
- plasma arc cutting
- laser welding
- laser cutting
- gas metal arc brazing.

Standards are not automatically bound by law but in case of an order or in a compulsory approval area the ISO 14175 and many other standards are automatically integrated. That means that moment when this standard is mentioned in a contract or an order once has to fulfil the requirements of this standard.

There are a few areas in which we are only allowed to use materials, constructions, parts and also tools with an approval like:

- Ship building,
- Bridge building,
- Railway vehicle manufacturing,
- Pressure vessel manufacturing,
- Steel framed building construction,
- Power plant building.

In these areas it is necessary to have valid approvals; even welders need to have a valid qualification. The registration requirement is not only limited to manufacturing sometimes it also includes repairing and service. Using material or parts without approval may have legal consequences. Registration requirements we can find in e.g.:

- Welding procedure specification,
- Welders qualification,

- Filler metal approval.

2.1 Welding procedure specification (WPS)

A WPS contents a lot of data concerning the welding fabrication. Included are base metal, thickness, preheating temperature, shape of weld and the welding procedure concerning parameters like:

- Welding process or method,
- Current,
- Voltage,
- Filler metal,
- …

Last but not least the shielding gas is also prescribed in the WPS (e.g.: ISO 14175 – M21 – ArC – 18). In this case the use of the required shielding gas is necessary otherwise the welded product is not in accordance with the requirements in the specification.

2.2 Welder's qualification (certificate)

In many applications qualified welders are required. After training a welder has to make a test and gets a verification document wherein it is written which kind of gas the welder used during the test. After that the welder is allowed to weld in accordance with his qualification. That means he has to keep the conditions of his qualification including same base metal, same welding process, same filler metal and same gases or gas mixtures belonging to the same group of gases he has used during his test.

2.3 Filler metal approval

To simplify registration and qualification procedures most of the welding wires have an approval so you can use them for welding in a liable to registration area like:

- Ship building
- Bridge building
- Railway vehicle manufacturing
- Pressure vessel manufacturing
- Steel framed building construction
- Power plant building.

These welding wires have guaranteed technical properties by adherence of the required welding parameters. The approval of a welding wire is also bound to a shielding gas. As the different components of a shielding gas mixture and their amounts have different effects to the welding process the shielding gas is specified as a group of gas mixtures with defined components in a limited range. Using a shielding gas of another group leads to the loss of the approval.

3. DIFFERENCES BETWEEN EN 439 AND ISO 14175

The new ISO 14175 is the substitute for the EN 439. Even if there is no defined period of transition we have such period. Some companies have filler metal on stock and have to use it a year after implementation of the ISO standard. Other companies have gas cylinders with old

designation or the registered welders with an old gas designation of the required shielding gas in their certificate. Therefore it is necessary to know the differences between the EN 439 and the ISO 14175. The differences are not very extensive but in some cases.

So in the following chapters we will explain the important contents and we will try to compare the two standards and show the important parts witch have to be regarded when working in a liable to registration area.

3.1 Properties of gas components

Regarding the properties of the different gas components nothing has changed as expected. The table 1 shows the properties of the components of the most popular gas mixtures.

Table 1: Properties of gas components [1]

Type of gas	Chem. symbol	Density[a] (air = 1,293) kg/m^3	Relative density[a] to air	Boiling point at 0,101 MPa °C	Reactivity during welding
argon	Ar	1,784	1,38	-185,9	inert
helium	He	0,178	0,138	-268,9	inert
CO2	CO2	1,977	1,529	-78,5 b	oxidizing
oxygen	O2	1,429	1,105	-183	oxidizing
nitrogen	N2	1,251	0,968	-195,8	low reactive[c]
hydrogen	H2	0,09	0,07	-252,8	reducing

[a)] Specified at 0 °C and 0,101 MPa (1,013 bar).
[b)] Sublimation temperature (solid to gas transition temperature).
[c)] The behaviour of nitrogen varies with different materials and applications. Possible influences must be considered by the user.

3.2 Tolerances of mixtures

Regarding the tolerances of gas mixtures the difference between the two standards consists of two facts (Table 2). The range lower or equal to 5 % in the ISO 14175 starts at 1 %. That means the tolerances of mixtures with components lower than 1% are not defined in this standard. The range over 5 % got expanded from 50 % to 100 %. Here we have no real difference because components higher than 50 % are as defined no longer a component. They are a base gas.

Table 2: Tolerances of gas components [1]

EN 439		**ISO 14175**		**Note**
components	tolerance	tolerance	components	
			< 1 %	in ISO 14175 not def.
0 % to 5 %	± 0,5 % absolute	± 0,5 % absolute	1 % to 5 %	
>5 % to 50 %	± 10 % relative	± 10 % relative	> 5 %	

3.3 Purity and moisture

The changes in purity and moisture (Table 3) are not very significant except in the case of oxygen and carbon dioxide. Especially carbon dioxide has a very high content of moisture based on the manufacturing process. For manufacturing gas mixtures for welding and allied processes mostly the purity 4.5 (99,995 %) of carbon dioxide is used. This prevents the mixtures from exceeding the moisture limits.

Table 3: Purities and moisture [1]

EN 439				**ISO 14175**			
Moisture [ppm] max.	Dew point, °C at 0,101 MPa	purity [%] min.	main group EN 439	main group ISO 14175	purity [%] min.	Dew point, °C at 0,101 MPa	Moisture [ppm] max.
40	-50	99,99	I	I	99,99	-50	40
40	-50	99,7	M1	M1[a]	99,9	-50	40
80	-44	99,7	M2	M2[a]	99,9	-44	80
120	-40	99,7	M3	M3[a]	99,9	-40	120
200	-35	99,7	C	C[a]	99,8	-40	120
40	-50	99,95	R	R	99,95	-50	40
40	-50	99,5	F	N	99,9	-50	40
200	-35	99,5	oxygen	O	99,5	-50	40
40	-50	99,5	hydrogen				
				NOTE: For certain applications a higher purity and/or lower dew point may be recommended to avoid possible oxidation and contamination [a]: Nitrogen: 1 000 ppm maximum.			

According to this most of the gases and gas mixtures sold for welding have higher purity and lower moisture content as required.

3.4 Classification - Main groups and sub groups

Gases and gas mixtures are divided into main and sub groups (Table 4). The intention of the main groups is to make a principal difference between inert, oxidizing, reducing and low reactive gases. This differentiation is important e.g. regarding the kind of metal – steel, aluminium, copper, titanium… In case of confusing the different gas components in these groups may have negative effects to the base metal, filler metal, the resulting welding seam or in some cases to the welding torch itself.

Table 4: Main groups – comparison [1]

DIN EN 439		**DIN EN ISO 14175**	
inert gases and inert gas mixtures	I	I	inert gases and inert gas mixtures
oxidising mixtures containing oxygen and/or carbon dioxide	M1, M2, M3	M1, M2, M3	oxidising mixtures containing oxygen and/or carbon dioxide
highly oxidising gas and highly oxidising mixtures	C	C	highly oxidising gas and highly oxidising mixtures
reducing gas mixtures	R	R	reducing gas mixtures
low reactive gas or reducing gas mixtures, containing nitrogen	F	N	low reactive gas or reducing gas mixtures, containing nitrogen
		O	oxygen
gas mixtures containing components not listed or mixtures outside the composition ranges are specified as special gases and get the letter S in front of the designation of the base gas mixture	S …	Z	gas mixtures containing components not listed or mixtures outside the composition ranges

The main groups, except Z, are divided into sub-groups. They are based on the presence and level of different components because they have different reactivity or influence to metallurgical reactions or to the physical properties of the arc.

At first sight only little has changed regarding the classification. The most important changes are the additionally divided groups EN 439-M21 into ISO 14175-M20 and ISO 14175-M21 and the EN 439-M24 into 4 further ISO 14175 groups (Table 5). As gas mixtures with less

than 15 % CO_2 in Argon are very popular, many companies will have a problem with their registration or the welders qualification. The same problem will happen to customers who used M24.

Table 5: Main and sub groups – comparison [1]

DIN EN 439								DIN EN ISO 14175							
Komponenten in Volumen-Prozent						Kurzbezeichnung		Kurzbezeichnung		Komponenten in Volumen-Prozent					
reaktions-träge	reduzierend	inert		oxidierend		Unter-gruppe	Haupt-gruppe	Haupt-gruppe	Unter-gruppe	oxidierend		inert		reduzierend	reaktions-träge
N_2	H_2	He	Ar	O_2	CO_2					CO_2	O_2	Ar	He	H_2	N_2
			100			1	I	I	1			100			
		100				2			2				100		
		>0 bis 95	Rest			3			3			Rest	0,5 = He = 95		
	>0 bis 5		Rest [2]		>0 bis 5	1	M1	M1	1	0,5 = CO_2 = 5		Rest [a]		0,5 = H_2 = 5	
			Rest [2]		>0 bis 5	2			2	0,5 = CO_2 = 5		Rest [a]			
			Rest [2]	>0 bis 3		3			3		0,5 = O_2 = 3	Rest [a]			
			Rest [2]	>0 bis 3	>0 bis 5	4			4	0,5 = CO_2 = 5	0,5 = O_2 = 3	Rest [a]			
			Rest [2]		>5 bis 25	1	M2	M2	0	5 < CO_2 = 15		Rest [a]			
									1	15 < CO_2 = 25		Rest [a]			
			Rest [2]	>3 bis 10		2			2		3 < O_2 = 10	Rest [a]			
			Rest [2]	>3 bis 10	>0 bis 5	3			3	0,5 = CO_2 = 5	3 < O_2 = 10	Rest [a]			
			Rest [2]	>0 bis 8	>5 bis 25	4			4	5 < CO_2 = 15	0,5 = O_2 = 3	Rest [a]			
									5	5 < CO_2 = 15	3 < O_2 = 10	Rest [a]			
									6	15 < CO_2 = 25	0,5 = O_2 = 3	Rest [a]			
									7	15 < CO_2 = 25	3 < O_2 = 10	Rest [a]			
			Rest [2]		>25 bis 50	1	M3	M3	1	25 < CO_2 = 50		Rest [a]			
			Rest [2]	>10 bis 15		2			2		10 < O_2 = 15	Rest [a]			
			Rest [2]	>8 bis 15	>5 bis 50	3			3	25 < CO_2 = 50	2 < O_2 = 10	Rest [a]			
									4	5 < CO_2 = 25	10 < O_2 = 15	Rest [a]			
									5	25 < CO_2 = 50	10 < O_2 = 15	Rest [a]			
					100	1	C	C	1	100					
				>0 bis 30	Rest	2			2	Rest	0,5 = O_2 = 30				
	>0 bis 15		Rest [2]			1	R	R	1			Rest [a]		0,5 = H_2 = 15	
	>15 bis 35		Rest [2]			2			2			Rest [a]		15 < H_2 = 50	
100						1	F	N	1						100
									2			Rest [a]			0,5 = N_2 = 5
									3			Rest [a]			5 < N_2 = 50
									4			Rest [a]		0,5 = H_2 = 10	0,5 = N_2 = 5
Rest	>0 bis 50					2			5					0,5 = H_2 = 50	Rest
								O	1		100				
							S	Z	Mischgase mit Komponenten , die nicht in der Tabelle aufgeführt sind oder Mischgase mit einer Zusammensetzung außerhalb der angegebenen Bereiche . [b]						

3.5 Designation

Table 6 presents the components in main and sub main groups. New is the designation of the cylinders. As in the past the classification (standard number group and sub group e.g.: EN 439 - M21) was satisfactory the designation in the context of the ISO requires the declaration of the hole components which the mixture consists of.

Some gas mixtures, the classification and the required full designation on the cylinders are shown in Table 7. In some cases the designation gets very long but the customer sees what he gets.

Table 7: Examples of classification and designation [1]

Classification	Designation
gas mixture containing 6 % carbon dioxide, 4 % oxygen in argon	
ISO 14175 – M25	ISO 14175 – M25 – ArCO – 6/4
gas mixture containing 30 % helium in argon	
ISO 14175 – I3	ISO 14175 – I3 – ArHe – 30
gas mixture containing 7,5 % argon, 2,5 % carbon dioxide in helium	
ISO 14175 – M12	ISO 14175 – M12 – HeArC – 7,5/2,5
gas mixture containing 30 % helium, 2 % hydrogen, 0,12 % CO2 in argon	
ISO 14175 – Z	ISO 14175 – Z-ArHeHC-30/2/0,12

Table 6: Components in main and sub groups [1]

symbol		components in nominal percentage of volume						application	notes
main group	sub group	oxidizing		inert		reducing	low reactive		
		CO_2	O_2	Ar	He	H_2	N_2		
I	1			100				GMAW, TIG, plasma welding, back shielding	inert
	2				100				
	3			balance	0,5 = He = 95				
M1	1	0,5 = CO_2 = 5		balance [a]		0,5 = H_2 = 5			low oxidizing
	2	0,5 = CO_2 = 5		balance [a]					
	3		0,5 = O_2 = 3	balance [a]					
	4	0,5 = CO_2 = 5	0,5 = O_2 = 3	balance [a]					
M2	0	5 < CO_2 = 15		balance [a]				GMAW	
	1	15 < CO_2 = 25		balance [a]					
	2		3 < O_2 = 10	balance [a]					
	3	0,5 = CO_2 = 5	3 < O_2 = 10	balance [a]					
	4	5 < CO_2 = 15	0,5 = O_2 = 3	balance [a]					
	5	5 < CO_2 = 15	3 < O_2 = 10	balance [a]					
	6	15 < CO_2 = 25	0,5 = O_2 = 3	balance [a]					
	7	15 < CO_2 = 25	3 < O_2 = 10	balance [a]					
M3	1	25 < CO_2 = 50		balance [a]					
	2		10 < O_2 = 15	balance [a]					
	3	25 < CO_2 = 50	2 < O_2 = 10	balance [a]					
	4	5 < CO_2 = 25	10 < O_2 = 15	balance [a]					
	5	25 < CO_2 = 50	10 < O_2 = 15	balance [a]					
C	1	100							high oxidizing
	2	balance	0,5 = O_2 = 30						
R	1			balance [a]		0,5 = H_2 = 15		TIG, back shielding, plasma welding, plasma cutting	reductive
	2			balance [a]		15 < H_2 = 50			
N	1						100	plasma cutting, back shielding	low reactive
	2			balance [a]			0,5 = N_2 = 5		
	3			balance [a]			5 < N_2 = 50		
	4			balance [a]		0,5 = H_2 = 10	0,5 = N_2 = 5		
	5					0,5 = H_2 = 50	balance		reductive
O	1		100						
Z	Gas mixtures containing components not listed, or mixtures outside the composition ranges listed. [b]								

[a] For the purpose of this classification, argon may be substituted partially or completely by helium.
[b] Two gas mixtures with the same Z-classification may not be interchangeable.

4. CONCLUSION

Although standards are not automatically bound by law, when mentioned in the contract they become accepted. It is important to consider ISO 14175 as a substitute for EN439. Gases and mixtures has to be designated according to new ISO 14175 standard. This should also be implemented in documentation, procedures, specifications, qualifications etc...

5. LITERATURE

[1] ISO 14175 – Welding consumables – Gases and gas mixtures for fusion welding and allied processes; 2008-03-01
[2] DIN EN 439 – Welding consumables – Shielding gases for arc welding and cutting; German version 1994
[3] DIN EN 287-1 – Approval testing of welders – Fusion welding – Part 1: Steel (includes amendment A1:1997); German version EN 287-1: 1992 + A1: 1997
[4] DIN EN 288 – Specification and approval of welding procedures for metallic materials – part 1 to part 8

NOTE: All table copies or combinations are from literature [1]: ISO 14175 – Welding consumables – Gases and gas mixtures for fusion welding and allied processes