Radiological impact of rutile covered welding electrodes

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Contents

1. Introduction

- Shielded metal arc welding
  - Covered welding electrodes: rod + covering
    - Covering contains NORM → Radiation exposure.
- Current context
  1. IAEA, 2011: International Basic Safety Standards.
  2. Council Directive 96/29/EURATOM, Title VII.
  3. Real Decreto 1439/2010.
  4. CSN: IS33 and Security Guide 11.2.
  5. Study on radioactivity of thoriated electrodes and its radiological impact on workers.

- Radiation exposure

1. During manufacture

1. Rutile and raw materials mixing	2. Cylinders production	3. Cylinders pressing	4. Electrodes pre - drying	5. Electrodes drying	6. Electrodes packing

2. During storage: raw materials/covered electrodes.
3. During residues management.
4. During welding: radon and dust inhalation.

2. Objectives

1. Analyse the radioactive content of the most sold covered electrodes in Spain.
   - Gamma spectrometry.
2. Determine the external effective dose on workers during manufacture, storage and residues management.
   - MCNP.
   - Ionisation chamber.
   - Environmental dosimetry.
   - Radiation Protection 122.

3. Why internal dose is not considered?

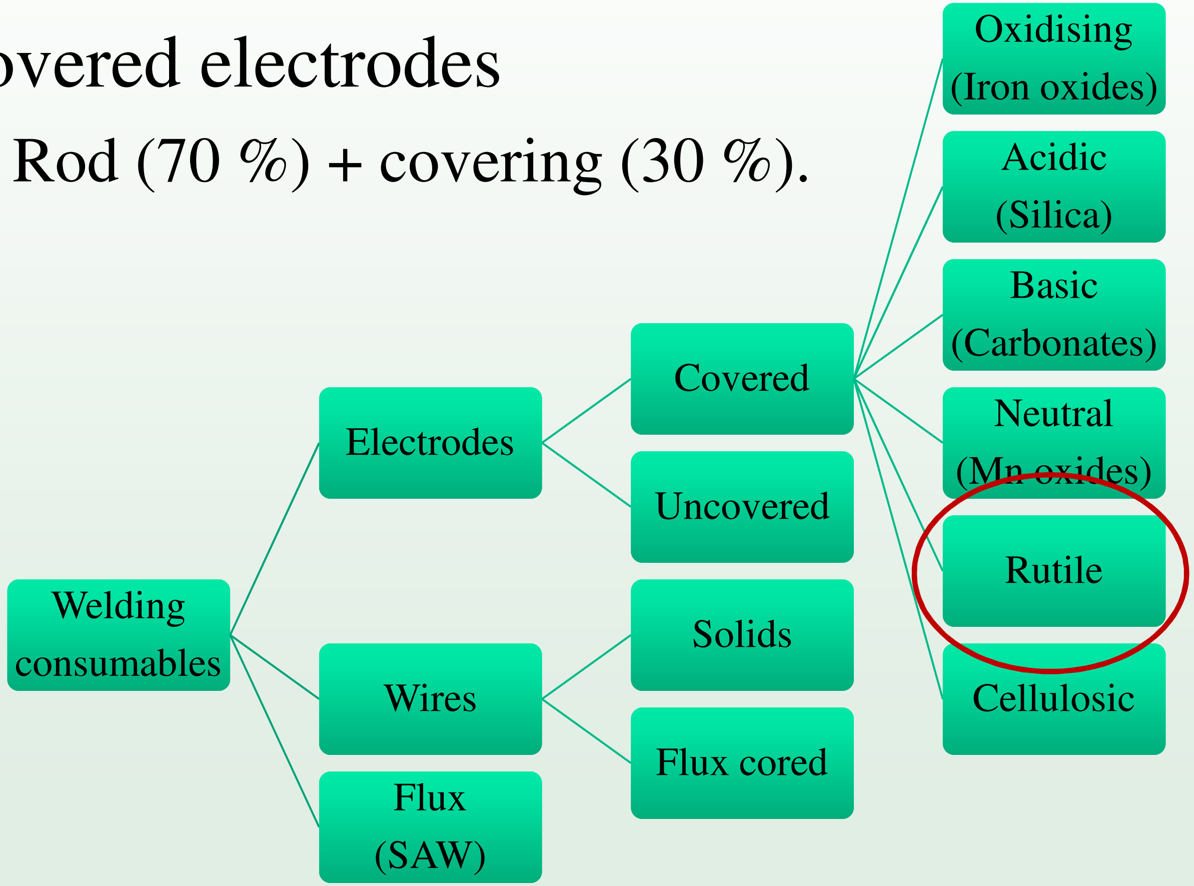
- Covered electrodes production facility
  - Only in mixture area.
  - Radon and dust sampling.
  - Dust measurement
    - Gamma spectrometry.
    - Radiochemical separation of Pb, Po, ^{226}Ra, Th and U.
  - DCAL.
  - Negligible dose.
- Welding
  - Same procedure.
  - Results are in progress and will be presented in future.
  - It seems to be a considerable internal dose.

3. Materials and methods

1. Materials

1. Covered electrodes

- Rod (70 %) + covering (30 %).



1. Materials

2. Gamma spectrometry

- High – Purity Germanium detector (HPGe).
- Gamma Vision 6.01.

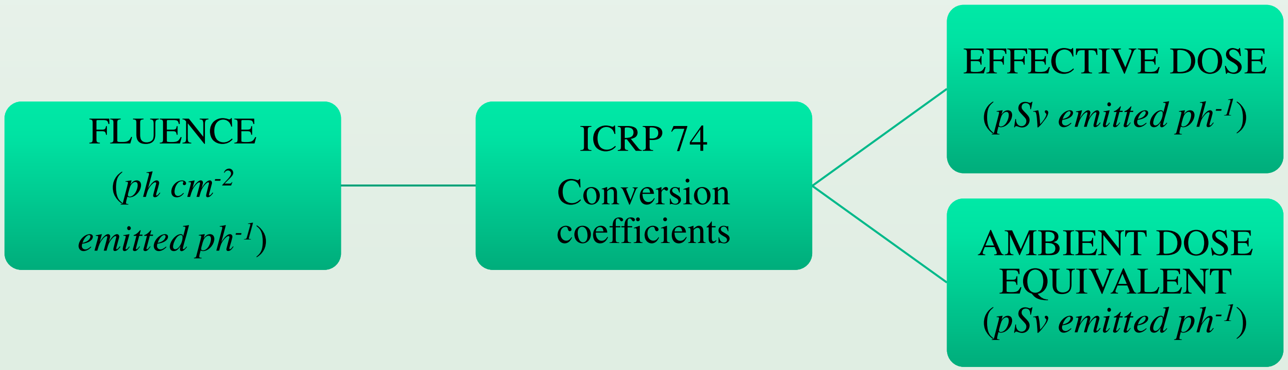
3. Ionisation chamber

- FHT 6020.
- *In situ* Ambient Equivalent Dose Rate (H*(10)).
- To validate the use of MCNP.

1. Materials

4. MCNP

- To analyse the transport of gamma rays.
- Must be defined: geometry, materials, source, photon energy and emission probability, detector type and position and number of histories.
- $P_{E_i} = \frac{A_i \cdot \gamma_{E_i}}{\Phi}$ where $\Phi = \sum_{E,i}(A_i \cdot \gamma_{E_i})$.
- Result:



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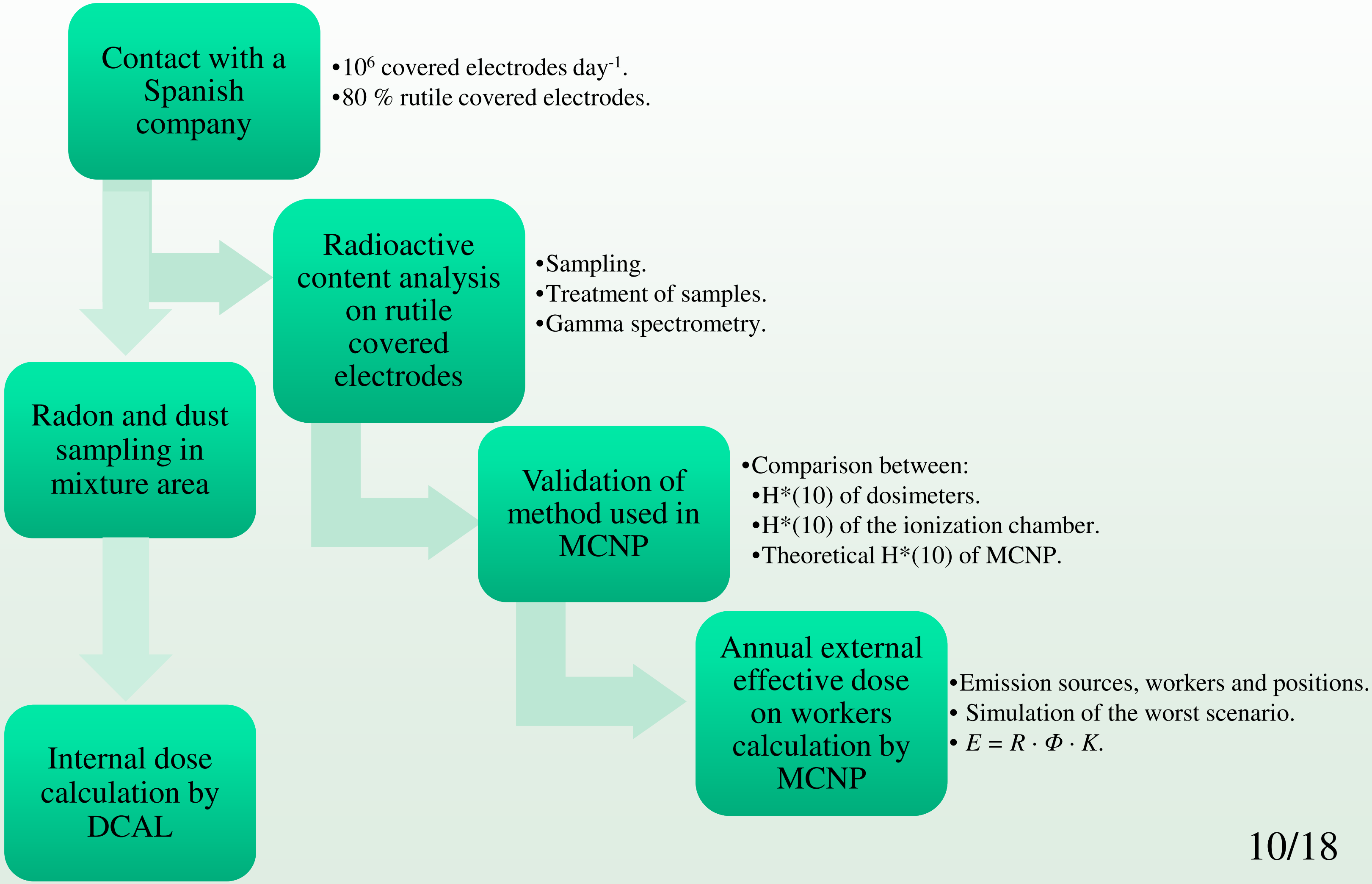
2. Methods



4. Results

1. Specific activity content

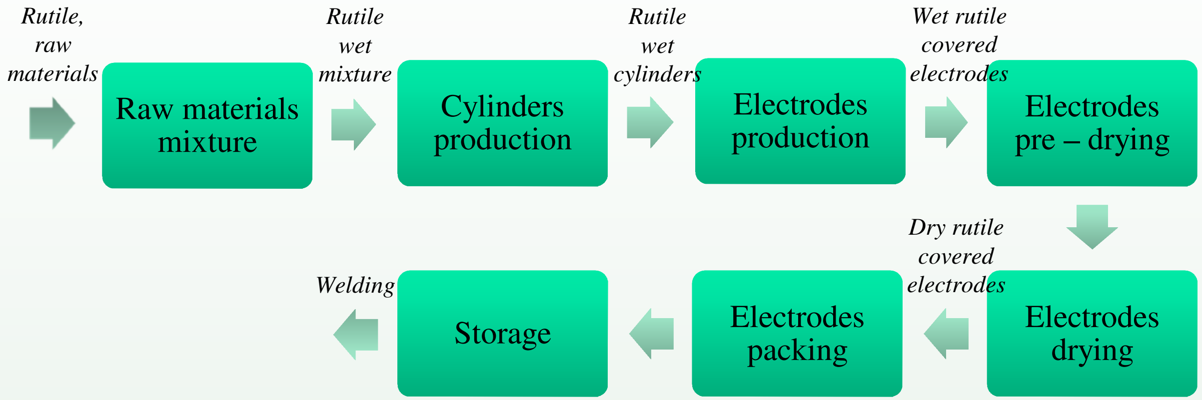
Natural Series/ Isotope	Rutile		Rutile mixture		Rutile covering	
	Sp. Activity Bq kg^{-1}	Uncertainty Bq kg^{-1}	Sp. Activity Bq kg^{-1}	Uncertainty Bq kg^{-1}	Sp. Activity Bq kg^{-1}	Uncertainty Bq kg^{-1}
^{232}Th	1.05E+02	1.75E+00	4.30E+01	1.08E+00	5.34E+01	1.27E+00
^{235}U	2.16E+01	1.26E+00	8.33E+00	1.00E+00	1.02E+01	9.50E-01
^{238}U	3.03E+02	7.20E+00	1.33E+02	5.00E+00	1.35E+02	3.81E+00
^{40}K			7.91E+02	1.06E+01	8.92E+02	1.05E+01

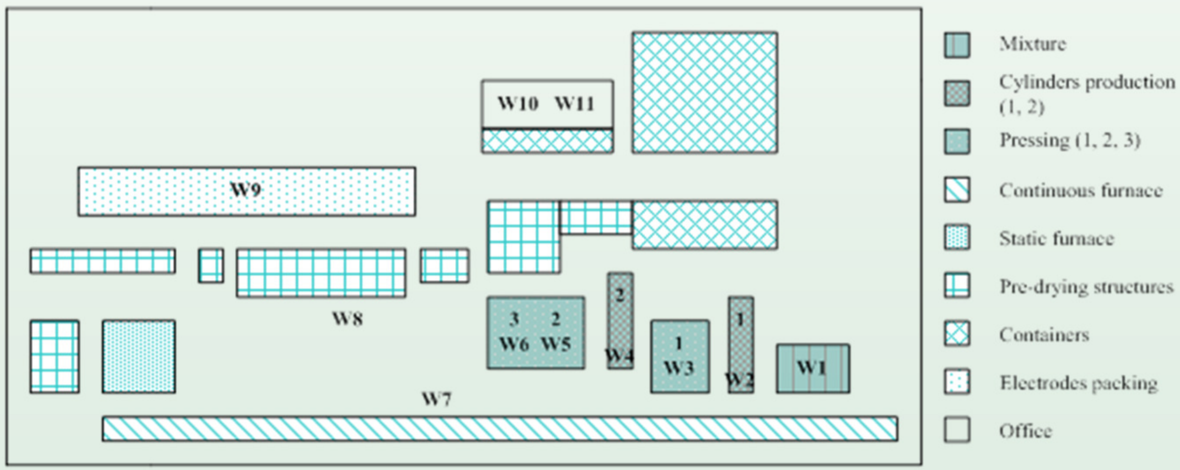
- No loss of radioactive materials.
- Natural series come from rutile, ^{40}K comes from other raw material.

2. Validation of MCNP data

- Experimental and theoretical results are compatible.

3. Effective dose by MCNP





- 6 stages, 11 source areas,12 workers and a worst possible scenario.

3. Effective dose by MCNP

Workers	Working h y^{-1}	Source areas: Mixture	Cylinders 1	Cylinders 2	Press 1	Press 2	Press 3	Furnace	Pre – drying	Containers	Packing	Hoppers	TOTAL DOSE (µSv a^{-1})
W1	1705	367.1						16.6	0.3	10.0			394.0
W2	53	8.0	1.4					1.5	0.0	0.2			11.1
W3	1705				0.3			24.3	0.6	7.3			32.5
W4	533			13.7				4.4	0.3	1.7			20.1
W5	1705					0.3		8.0	1.9	3.5			13.7
W6	1705						0.3	8.1	2.2	2.4			13.0
W7	1705							48.3	1.3	1.9			51.5
W8	1705								73.7	1.1			74.8
W9	1705								6.5	0.3	3.2		10.0
W10	852								1.3	3.1			4.4
W11	1364								2.6	5.6			8.2
W12	44.4											0.7	0.7

- The maximum effective dose is in mixture area.
- Annual external effective dose < dose limit for public (1 mSv a^{-1}).

4. Dose in final products store

- 0,40 nSv path^{-1} = **0,68** µSv a^{-1} < 1 mSv a^{-1}.

5. Dose in raw materials store

- 0,16 nSv path^{-1} = **0,27** µSv a^{-1} < 1 mSv a^{-1}.

6. Doses during residues management

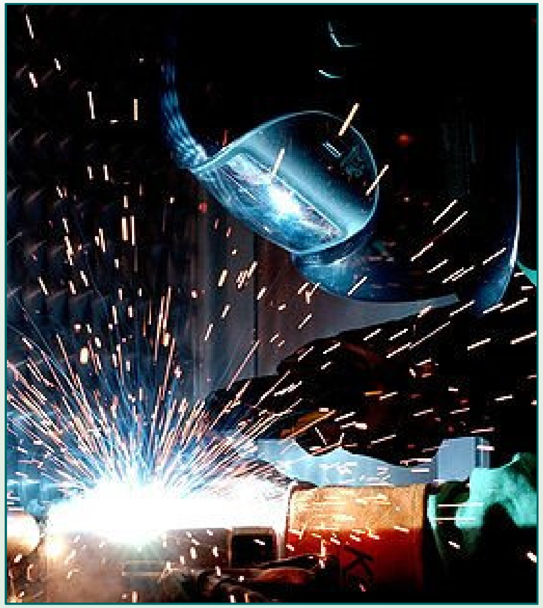
Radiation protection 122	
Stages	Doses (µSv a^{-1})
Inside storage	3,03
Short distance transport	0,23
Outside storage	0,09
Long distance transport	0,05
Landfill	43,00

5. Conclusions

1. Rutile is the most radioactive covering.
2. Experimental and theoretical results are compatible.
3. Mixture area is the worst area.
4. Annual external effective doses don’t exceed dose limit for public (1 mSv y^{-1}).
5. There is **no relevant radiological impact**.

Then…

Value of internal dose in welding is going to be calculated and published in other paper.



Acknowledgments

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Thank you for your attention.
Aitäh!