



University of Turin,
Department of Chemistry



 **MERCK & ELSEVIER**
Young Chemists Symposium



Società Chimica Italiana
Gruppo Giovani

By-products analysis of a pyrolysis plant powered by plastic waste materials for energy's production

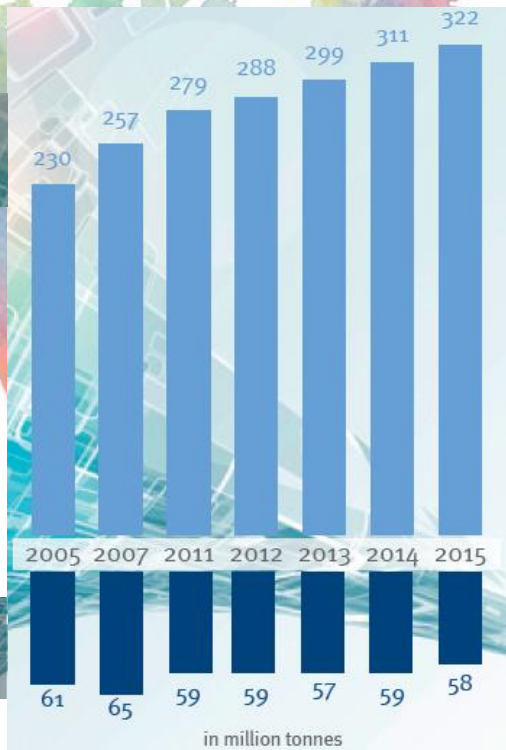
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Rimini, 19th November 2018

WORLD



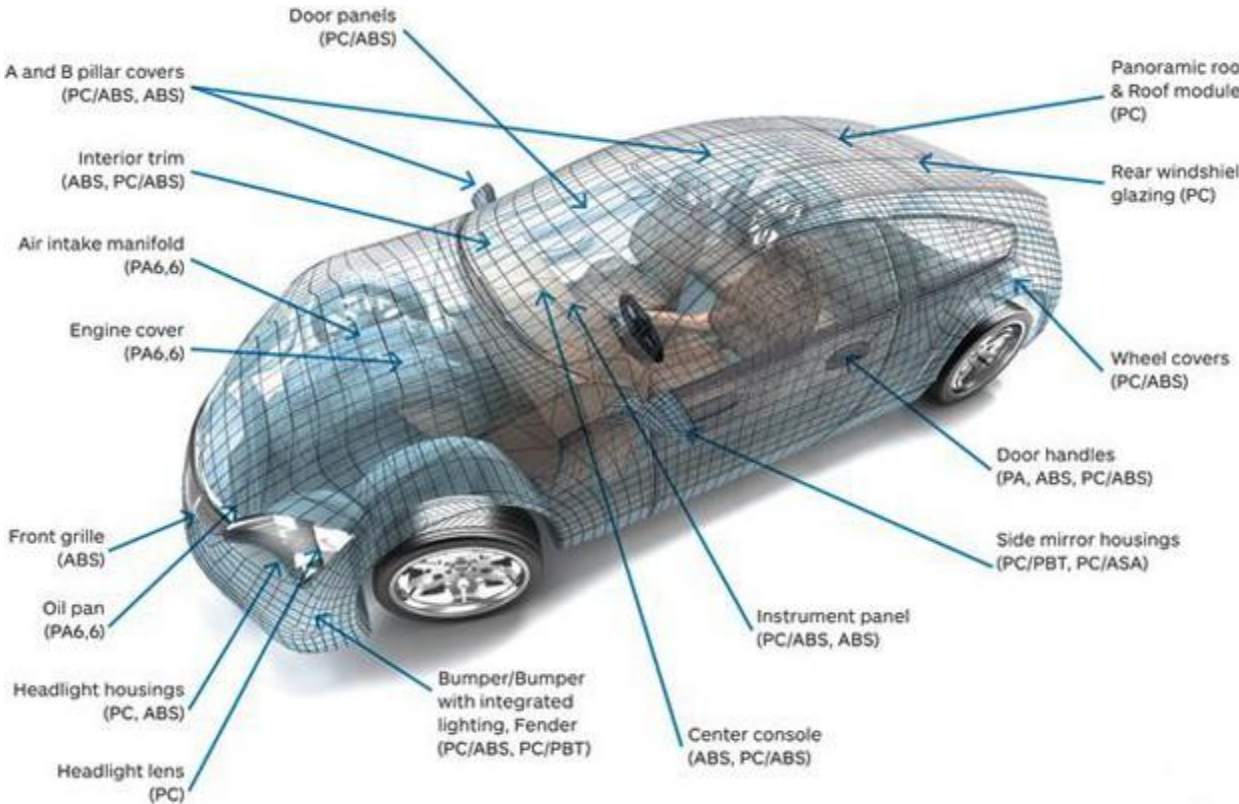
Worldwide and European plastic production

EUROPE

(EU28+NO/CH)



Plastic demand in Europe for each field

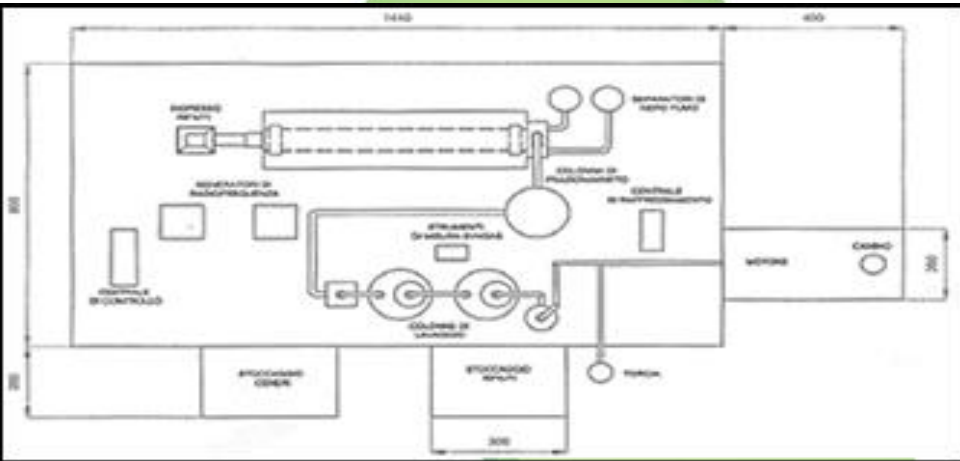


- **PP**: bumpers, wires isolation, fiber carpers
- **PU**: seat paddings, insulating panels
- **PVC**: sheaths electric wires, pipes, flame retardants
- **ABS**: dashboards, klacson
- **PA**: textile fibers
- **PC**: bumpers, lights
- **PMMA**: windows, mirrors, display

Recycling: automotive



Dump



Pyrolysis Plant

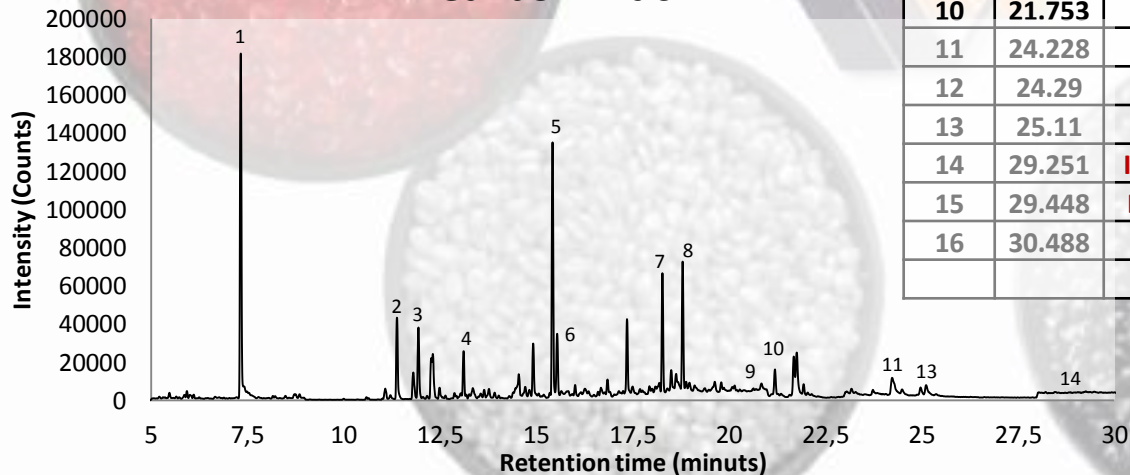


Aim of the work

- PAHs and PCBs analysis on carbon black, ashes, bitumen.
- Other analysis on washing waters were also performed.
- Identifying the possible re-use of this byproducts of the plant

NO PCB FOUND

Carbon Black

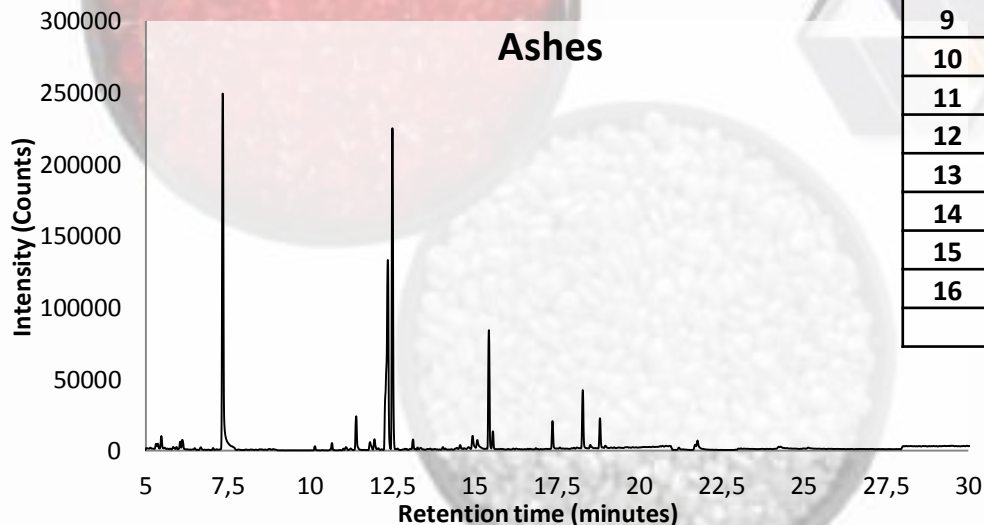


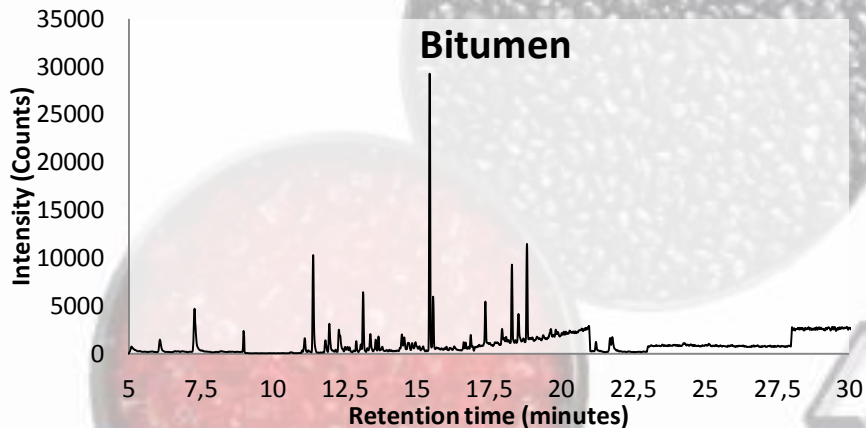
N°	RT (min.)	PAHs	Concentration (mg/kg)	TEF	TE (mg/kg)
1	7.324	Naphthalene	237	0.001	0.237
2	11.379	Acenaphthylene	54.8	0.001	0.055
3	11.826	Acenaphthene	7.2	0.001	0.007
4	13.106	Fluorene	24.9	0.001	0.025
5	15.417	Phenanthrene	112	0.001	0.112
6	15.538	Anthracene	26.3	0.010	0.263
7	18.269	Fluoranthene	54.8	0.001	0.055
8	18.792	Pyrene	60.8	0.001	0.061
9	21.674	Benz[a]anthracene	45.1	0.100	4.507
10	21.753	Chrysene	35.2	0.010	0.352
11	24.228	Benzo[b]fluoranthene	76.6	0.100	7.658
12	24.29	Benzo[k]fluoranthene	n.d.	0.100	n.d.
13	25.11	Benzo[a]pyrene	57.7	1.000	57.7
14	29.251	Indeno[1,2,3-cd]pyrene	40.4	0.100	4.041
15	29.448	Dibenz[a,h]anthracene	n.d.	1.000	n.d.
16	30.488	Benzo[ghi]perylene	34.4	0.001	0.034
		SUM	867.7		75.1

NO PCB FOUND

N°	RT (min.)	PAHs	Concentration (mg/kg)	TEF	TE (mg/kg)
1	7.324	Naphthalene	4.78	0.001	4.78E-03
2	11.379	Acenaphthylene	0.411	0.001	4.11E-04
3	11.826	Acenaphthene	0.051	0.001	5.14E-05
4	13.106	Fluorene	0.097	0.001	9.68E-05
5	15.417	Phenanthrene	0.913	0.001	9.13E-04
6	15.538	Anthracene	0.136	0.010	1.37E-03
7	18.269	Fluoranthene	0.504	0.001	5.04E-04
8	18.792	Pyrene	0.255	0.001	2.55E-04
9	21.674	Benz[a]anthracene	0.080	0.100	8.01E-03
10	21.753	Chrysene	0.171	0.010	1.71E-03
11	24.228	Benzo[b]fluoranthene	0.083	0.100	8.36E-03
12	24.29	Benzo[k]fluoranthene	0.067	0.100	6.70E-03
13	25.11	Benzo[a]pyrene	0.197	1.000	1.97E-01
14	29.251	Indeno[1,2,3-cd]pyrene	n.d.	0.100	n.d.
15	29.448	Dibenz[a,h]anthracene	n.d.	1.000	n.d.
16	30.488	Benzo[ghi]perylene	n.d.	0.001	n.d.
		SUM	7.75		0.231

Ashes





N°	RT (min.)	PAHs	Concentration (mg/kg)	TEF	TE (mg/kg)
1	7.324	Naphthalene	311	0.001	0.311
2	11.379	Acenaphthylene	1891	0.001	1.891
3	11.826	Acenaphthene	n.d.	0.001	n.d.
4	13.106	Fluorene	998	0.001	0.998
5	15.417	Phenanthrene	3490	0.001	3.490
6	15.538	Anthracene	671	0.010	6.709
7	18.269	Fluoranthene	1066	0.001	1.066
8	18.792	Pyrene	1377	0.001	1.377
9	21.674	Benz[a]anthracene	496	0.100	49.6
10	21.753	Chrysene	480	0.010	4.803
11	24.228	Benzo[b]fluoranthene	n.d.	0.100	n.d.
12	24.29	Benzo[k]fluoranthene	n.d.	0.100	n.d.
13	25.11	Benzo[a]pyrene	n.d.	1.000	n.d.
14	29.251	Indeno[1,2,3-cd]pyrene	n.d.	0.100	n.d.
15	29.448	Dibenz[a,h]anthracene	n.d.	1.000	n.d.
16	30.488	Benzo[ghi]perylene	n.d.	0.001	n.d.
		SUM	10782		70.2

PAHs	Sample	Road surface bitumen 1	Road surface bitumen 2	Tar pitch
	mg/kg	mg/kg	mg/kg	mg/kg
Fenanthrene	3490	0.4-3.5	1.7-7.3	19800-25700
Anthracene	670	n.d.	<0.1-0.3	64000-76000
Fluoranthene	1066	n.d. - 2.0	0.4-0.7	29000-36000
Pyrene	1377	0.3-8.3	0.3-1.5	21300-27200
Crysene	480	<0.1-8.9	0.5-3.9	11200-22700
Benzo(a)anthracene	495	n.d.-2.1	0.1-1.1	20400-24500

NO PCB FOUND

Results: Washing waters

Parameters	Unit of Measure	Washing water	Discharge limits into surface waters(*)	Discharge limits into sewage (*)
COD (as O ₂)	mg/L	12111	≤ 160	≤ 500
Al	mg/L	n.d.	≤ 1	≤ 2.0
Ba	mg/L	0.083	≤ 0.5	≤ 0.5
Cd	mg/L	< 0.03	≤ 0.02	≤ 0.02
Cr	mg/L	n.d.	≤ 2	≤ 4
Fe	mg/L	n.d.	≤ 2	≤ 4
Mn	mg/L	0.161	≤ 2	≤ 4
Hg	mg/L	n.d.	≤ 0.005	≤ 0.005
Ni	mg/L	0.122	≤ 2	≤ 4
Pb	mg/L	n.d.	≤ 0.2	≤ 0.3
Cu	mg/L	1.02	≤ 0.1	≤ 0.4
Se	mg/L	0.172	≤ 0.03	≤ 0.03
Sn	mg/L	< 1	≤ 10	-
Zn	mg/L	46.45	≤ 0.5	≤ 1.0
Total cyanides (as CN ⁻)	mg/L	100	≤ 0.5	≤ 1.0
Sulfates	mg/L	n.d.	≤ 1	≤ 2
Chlorides	mg/L	175	≤ 1200	≤ 1200
Fluorides	mg/L	3.27	≤ 6	≤ 12
P total	mg/L	n.d.	≤ 10	≤ 10
NH ₄	mg/L	24.5	≤ 15	≤ 30
Phenols	mg/L	3220	≤ 0.5	≤ 1

**Discharge limits into surface waters and sewage as pointed into D. Lgs. 152/06*

Proposal for their reuse:

- **Carbon Black**: - *Additive for tires*
- *High temperature treatment for PAHs removal*
- **Ashes**: *Possible reuse as inert into concrete production*
- **Bitumen**: *Possible reuse as road surface pavement, after rheological properties control*
- **Washing waters**: *High content of pollutants (phenols, cyanides and COD)*



Disposal as HAZARDOUS WASTE



THANK YOU FOR THE ATTENTION!



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