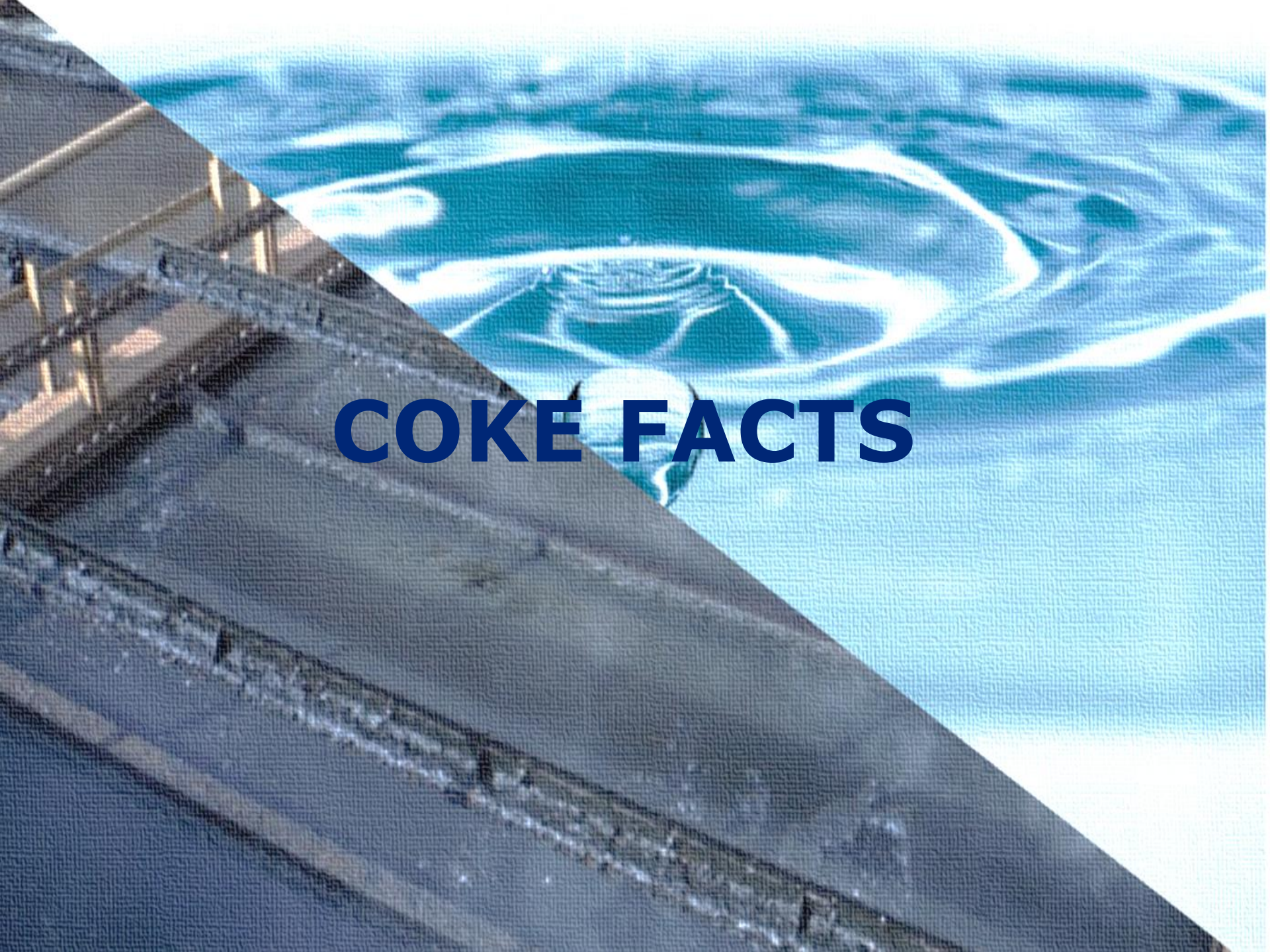
INSTITUTE FOR CHEMICAL PROCESSING OF COAL

1955-2016

Coke oven wastewater – formation, treatment and utilization methods – a review

Anna Kwiecińska, Sławomir Stelmach, Jan Figa, Maciej Chrubasik

ECOpole 2016, Zakopane, 5-8,10.2016


COKE FACTS

Coke is produced by the **destructive distillation** of coal in coke ovens;

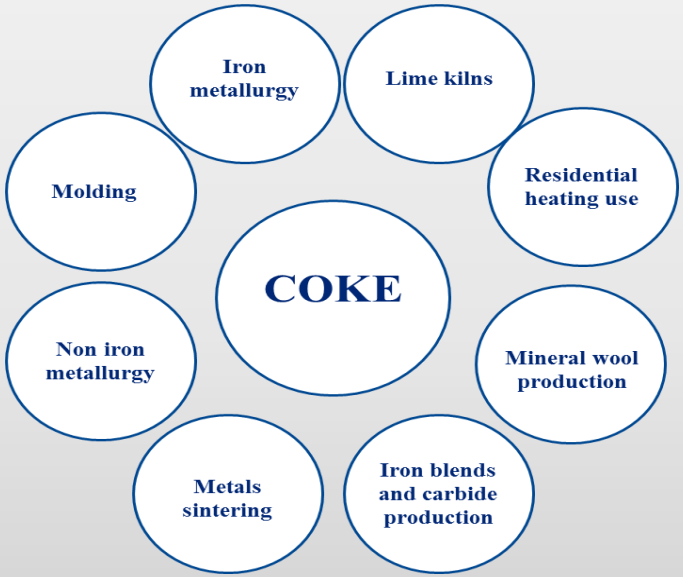
Coal blend (various types of coal of desired coking parameters) is coked (oxygen free atmosphere) until most **volatile components are removed**;

Coal blend

Coking

Coke

The remaining material is **a carbon mass called coke**, and it is used in various processes, among which **pig iron production** is the most significant;



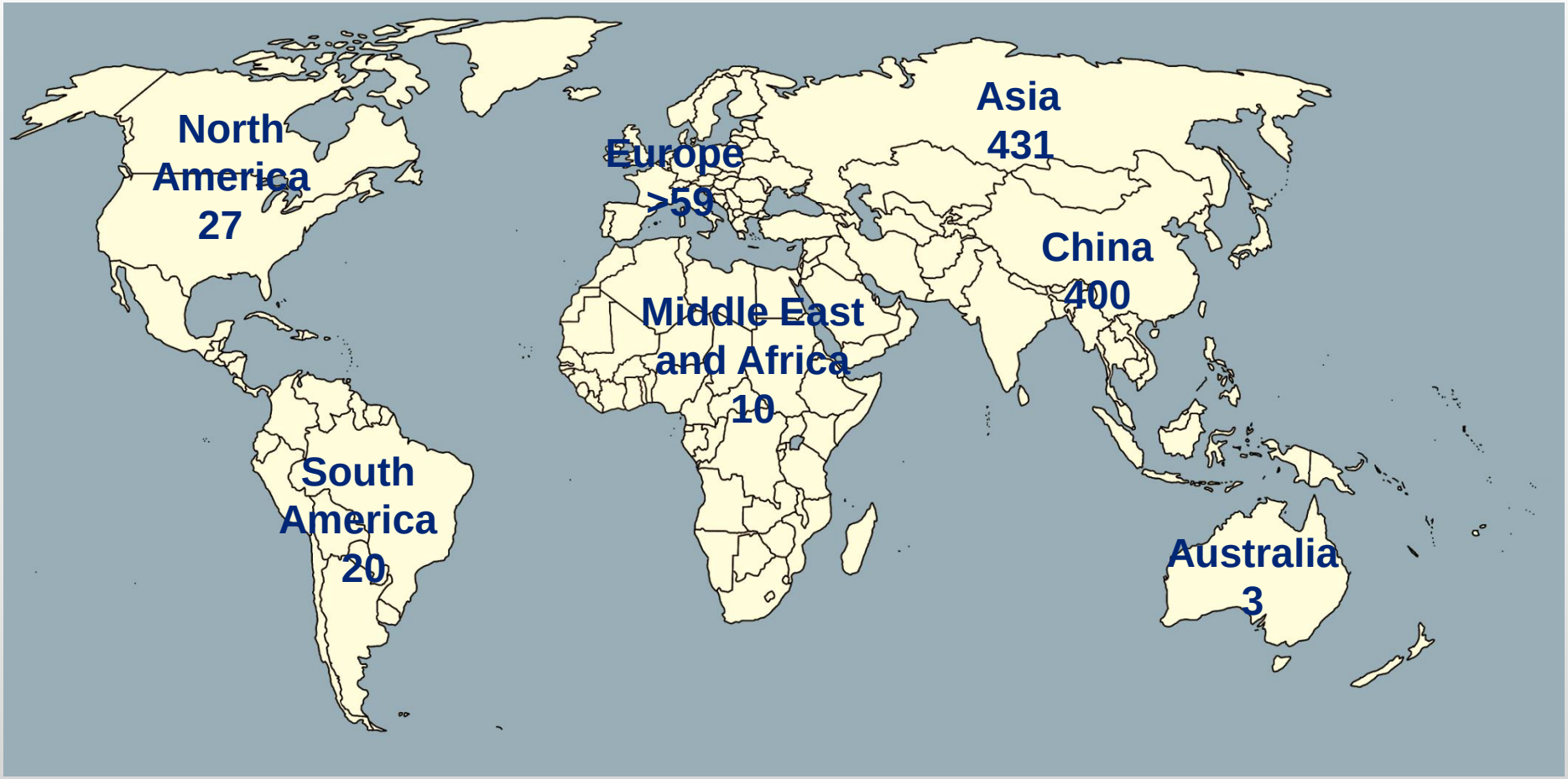
Coke uses

Pig iron

Over **90% of the total coke production** is dedicated to **blast furnace operations**

There are **538 coke plants** in the world.

Most of them (400, each with over 600,000 t/y capacity) are located **in China.**



China is also the biggest producer of coke in the world.
Its production in 2014 reached **490.3 Mt**, while for the rest of the producers in top 10 it was 174 Mt.

No.	State	2010	2011	2012	2013	2014
1	China	387.6	426.2	441.6	474.0	490.3
2	Japan	37.0	37.4	36.0	36.5	37.0
3	India	26.3	30.3	31.7	32.9	34.1
4	Russia	29.1	29.6	29.8	28.5	29.5
5	South Korea	14.6	17.0	16.9	16.7	18.5
6	Ukraine	18.6	19.6	18.9	17.5	13.8
7	USA	13.6	14.0	13.8	13.9	13.7
8	Brazil	9.0	10.1	10.0	10.6	10.6
9	**Poland**	**9.7**	**9.1**	**8.6**	**9.2**	**9.4**
10	Germany	7.9	8.1	7.9	8.2	8.3

9 coke oven plants

25 batteries

JSW KOKS SA
GRUPA JSW

(5)

- Coke Plant Jadwiga, Zabrze,
- Coke Plant Przyjaźń, Dąbrowa Górnicza,
- Coke Plant Dębieńsko, Dębieńsko,
- Coke Plant Radlin, Radlin,
- Coke Plant Victoria, Wałbrzych.

ArcelorMittal

(2)

- Coke Plant Zdzieszowice,
- Coke Plant Kraków.

Private sector (2)

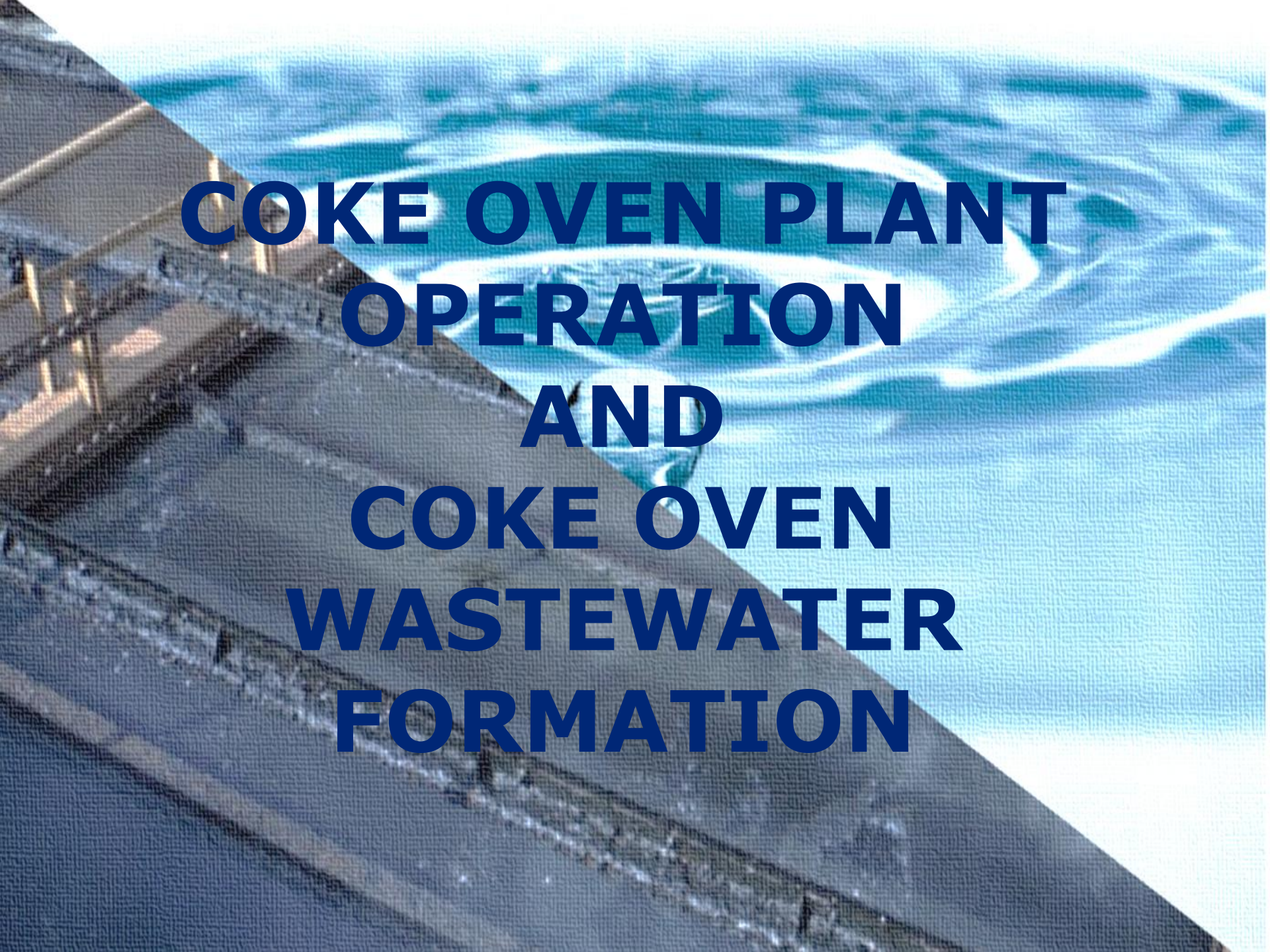
- Coke Plant Częstochowa Nowa, Częstochowa,
- Coke Plant Carbo Koks, Bytom.

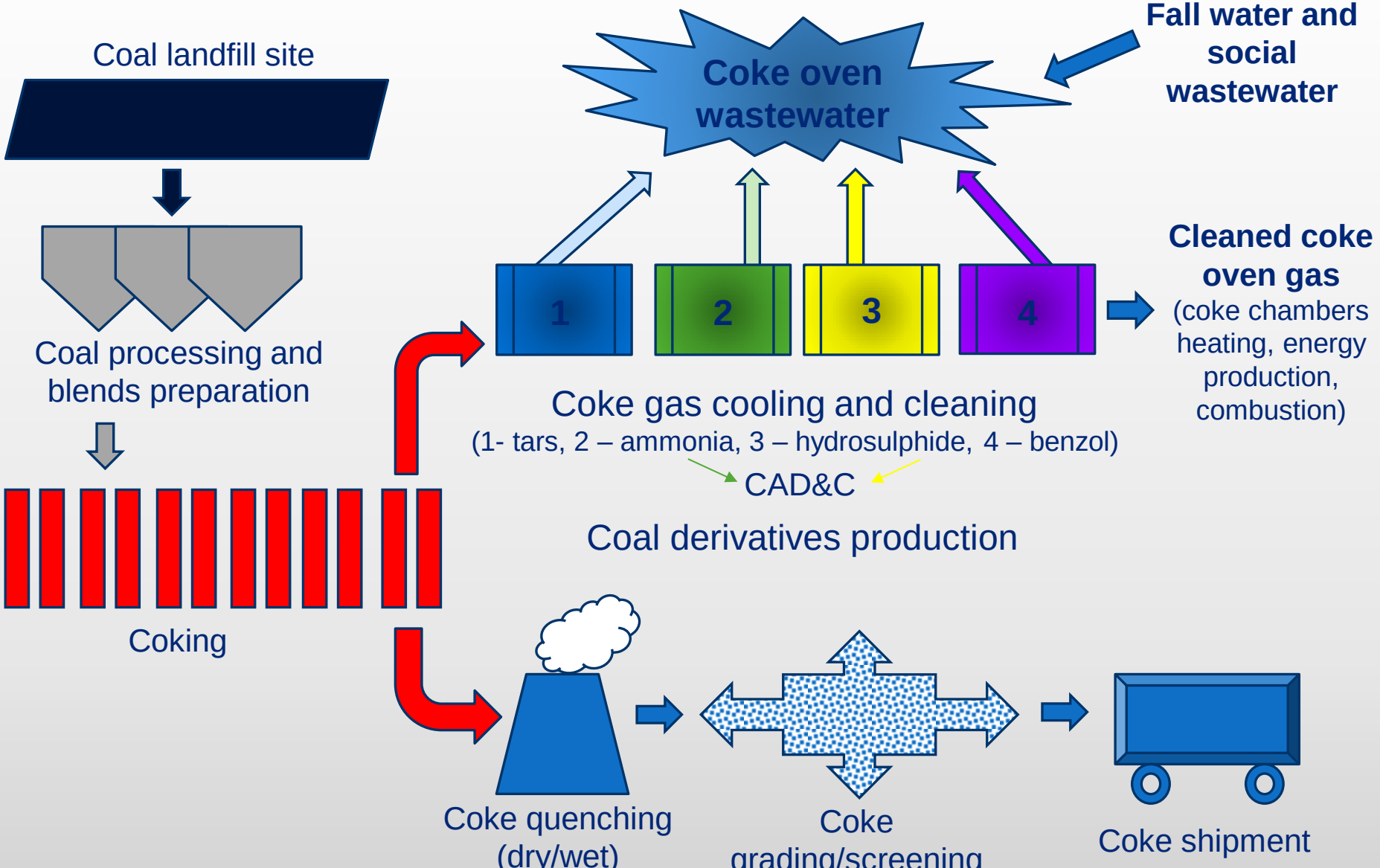
NOWA
KOKSOWNIA CZĘSTOCHOWA

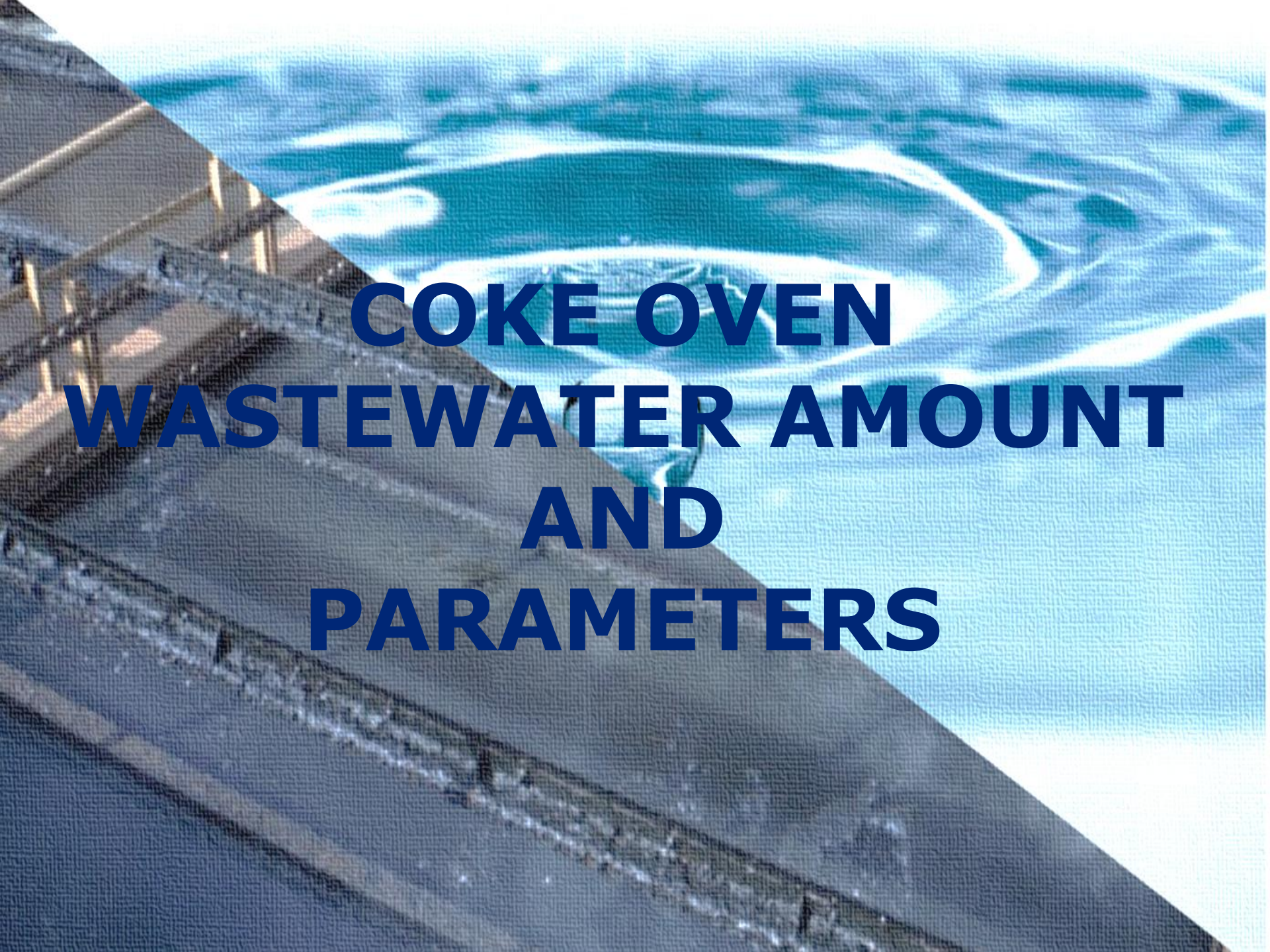
CARBO - KOKS
SPÓŁKA z o.o.

Koksownia Przyjaźń
The biggest Polish COP
The youngest European COP
5 batteries, 750 kT/y

Koksownia Zdzieszowice
The biggest European COP
8 batteries, 4200 kT/y


COKE OVEN PLANT
OPERATION
AND
COKE OVEN
WASTEWATER
FORMATION


Coke oven wastewater
Fall water and social wastewater
Coal landfill site
Coal processing and blends preparation
1
2
3
4
Cleaned coke oven gas
(coke chambers heating, energy production, combustion)
Coke gas cooling and cleaning
(1- tars, 2 – ammonia, 3 – hydrosulphide, 4 – benzol)
CAD&C
Coal derivatives production
Coking
Coke quenching (dry/wet)
Coke grading/screening
Coke shipment



COKE OVEN WASTEWATER AMOUNT AND PARAMETERS

Wastewater is generated at an average rate ranging from **0.3 to 4** m^3 per ton of coke

Parameter	Unit	Concentration
pH	-	7-9,5
Spec. cond.	µS/cm	5000-12500
COD	mgO_2/dm^3	2400-4200
BOD_5	mgO_2/dm^3	500-1500
Tars	mg/dm^3	5-150
Sulphides	mg/dm^3	10-50
Cyanides	mg/dm^3	5-20
Thicyanates	mg/dm^3	50-420
Phenols	mg/dm^3	150-1200
Ammonia	mg/dm^3	120-790
Chlorides	mg/dm^3	2500-3500
Sulphates	mg/dm^3	900-1200

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Sulphides	**mg/dm^3**	**10-50**
Cyanides	**mg/dm^3**	**5-20**
Thiocyanates	**mg/dm^3**	**50-420**
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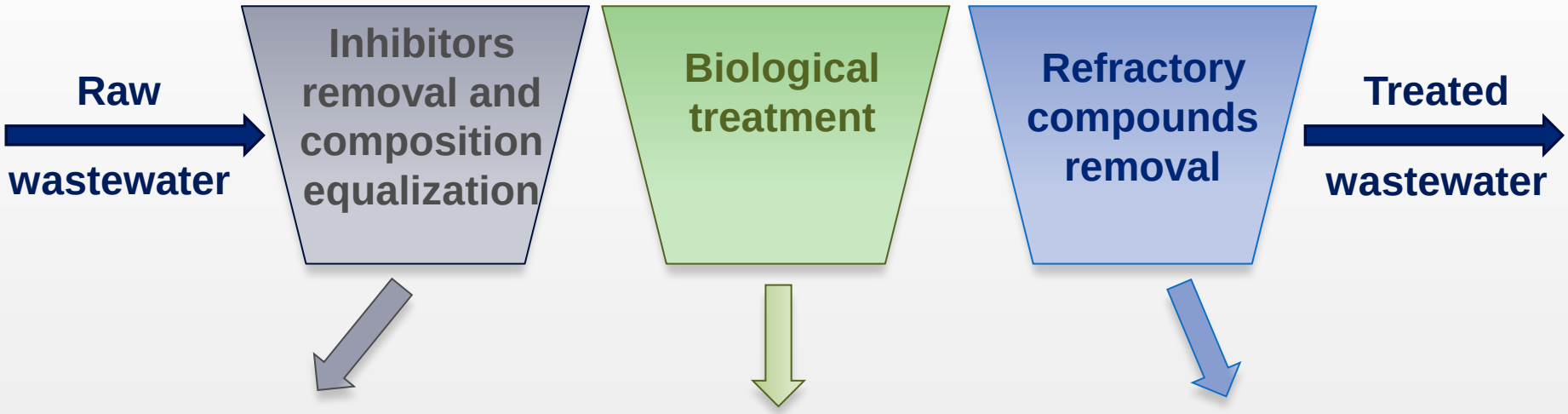
Coke oven wastewater treatment and utilization

Coke oven wastewater treatment



MECHANICAL METHODS
- Sedimentation
- Flotation
- Filtration

CHEMICAL METHODS
- Coagulation

REMOVAL OF TARS, SULPHIDES, CYANIDES

NITRIFICATION
- Oxidation of N-NH_3 to N-NO_3

DENITRIFICATION
- Reduction of N-NO_3 to N_2

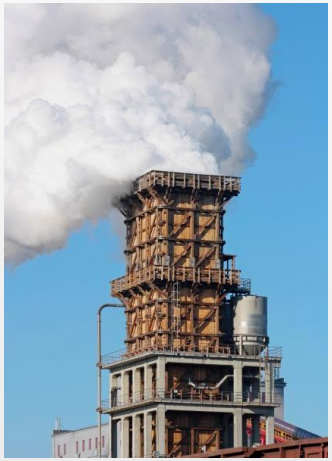
CARBON SOURCE FOR BIOLOGICAL PROCESSES - PHENOLS

MULTIFICTIONAL REACTORS
- Activated carbon adsorption
- Coagulation
- AOPs

Treated wastewater

Wet coke quenching

- S^{2-} <0.2 mg/dm^3
- CN^- <0.1 mg/dm^3
- Phenols <15 mg/dm^3
- N_{NH3} <82 mg/dm^3
- Chlorides + sulphates – depends on required coke quality



Environment

BAT conclusions:

- COD <220 mg/dm^3
- BOD_5 <20 mg/dm^3
- S^{2-} <0.1 mg/dm^3
- CN^- <0.1 mg/dm^3
- SCN^- <4 mg/dm^3
- Phenols <0.5 mg/dm^3
- N_{tot} 15-50 mg/dm^3

Disadvantages and limitations

- Inefficient performance of processes – standards exceeding,
- Effective cyanides removal cannot be nowadays obtained,
- Conventional cyanides removal - coagulation,
- Cyanides competing contaminants – tars and sulphides,
- Large doses of chemicals (coagulants) required,
- Effective removal of cyanides and sulphides is crucial for proper run of biological processes (inhibitors!!!!),
- Additional large salts load with coagulants,
- Affection of coke quality and exceeding of environmental standards,
- Water recovery is not even considered,
- Additional requirements for fresh water preparation and use.

- **One of the most complex and problematic industrial wastewater – many researches and projects,**
- **Sharpening of environmental and coke quality standards,**
- **Conventional systems are the basis of every research,**
- **Main priorities:**
  - Cyanides removal improvement,
  - Biological processes enhancement,
  - Salts load decrease,
  - Technological grade water recovery.

Proposal idea 2014

Proposal preparation and sumbission 2015

European Commission acceptance, project start 2016

PROJECT CONSORTIUM

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION
Industrial Technologies
Coal and steel

GRANT AGREEMENT

NUMBER — 710078 — INNOWATREAT

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **European Union (EU)** ('the Agency'), under the power delegated by the European Commission ('the Commission'),

represented for the purposes of signature of this Agreement by Head of Unit - Administration and Finance, DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION, Industrial Technologies, Administration and finance, Patrik KOLAR,

and

on the other part,

1. 'the coordinator':

INSTYTUT CHEMICZNEJ PRZEROBKI WEGLA (IChPW), 000025945, established in UL. ZAMKOWA 1, ZABRZE 41 803, Poland, PL6480008765 represented for the purposes of signing the Agreement by Michal JANASIK

and the following other beneficiaries, if they sign their 'Accession Form' (see Annex 3 and Article 56):

2. **POLITECHNIKA WROCLAWSKA (PWR)**, 000001614, established in WYBRZEZE WYSPIANSKIEGO 27, WROCLAW 50370, Poland, PL8960005851

3. **AKVOLUTION GMBH (Akvola)** GMBH, HRB153250B, established in STRASSE DES 17 JUNI 135, BERLIN 10623, Germany, DE291437109

4. **CESKE VYSOKE UCENI TECHNICKE V PRAZE (CVUT)**, 68407700, established in ZIKOVA 4, PRAHA 16636, Czech Republic, CZ68407700

5. **POLITECHNIKA KRAKOWSKA (PK)**, 854, established in WARSZAWSKA 24, KRAKOW 31 155, Poland, PL6750006257

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THANK YOU FOR YOU ATTENTION