TREATMENT OF A FORGING INDUSTRY WASTEWATER CONTAINING GRAPHITE AND SLUDGE CHARACTERIZATION

Viviana Nedel Reckziegel

R. F. Thiesen, E. Osório, I. A. H. Schneider

LTM –DEMIN- PPGE3M, LASID –DEMET- PPGE3M,
Universidade Federal do Rio Grande do Sul
Av. Bento Gonçalves, 9500 – CEP: 91501-970, Porto Alegre, RS, Brazil

Summary

- Introduction
- Materials and Methods
- Results and Discussion
- Conclusions
- Acknowledgments

Introduction

Forging is a manufacturing process involving the shaping of metal using localized compressive forces.

Lubrificant:

1) Reduce the metal-metal friction,
2) Aiming at enabling the removal of the forged part from inside the matrix,
3) Cool and protect ,
4) Extend the useful life of the matrices .

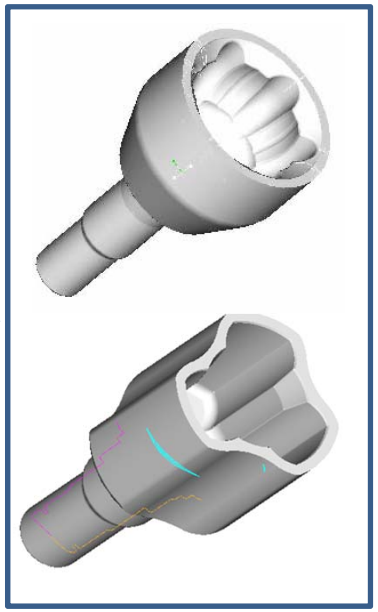
Types of Lubricants

General characteristics of lubricants used in the forging process.

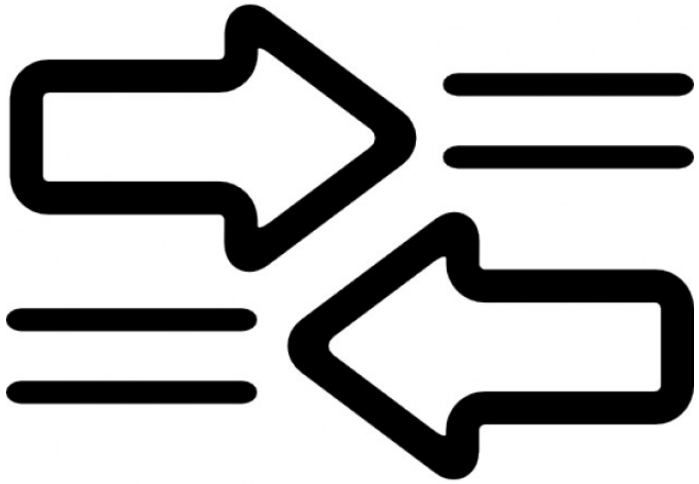
TYPE OF LUBRICANT	ADVANTAGES	DISADVANTAGES
Graphite Oil-based	Increases lifetime Applicable in a wide range of forging operations. Resistance.	Generation of highly polluting and difficult to treat effluents Emission of small amount of smoke
Graphite Water-based	Increases array life Does not generate smoke Less environmentally aggressive Easy dilution in water	Graphite particles may be emitted, possibly damaging electrical systems or accumulating on the shop floor.
Synthetic	Applied in forges that work with specific alloys and in cutting-edge industries	High cost
Solid-based	Replaces 100% of lubricants	High cost, limited to places where conventional types can not be used. Low complexity parts.

Introduction

Forging Press



Change in Process



Oil-based graphite lubricant

Water-based lubricant

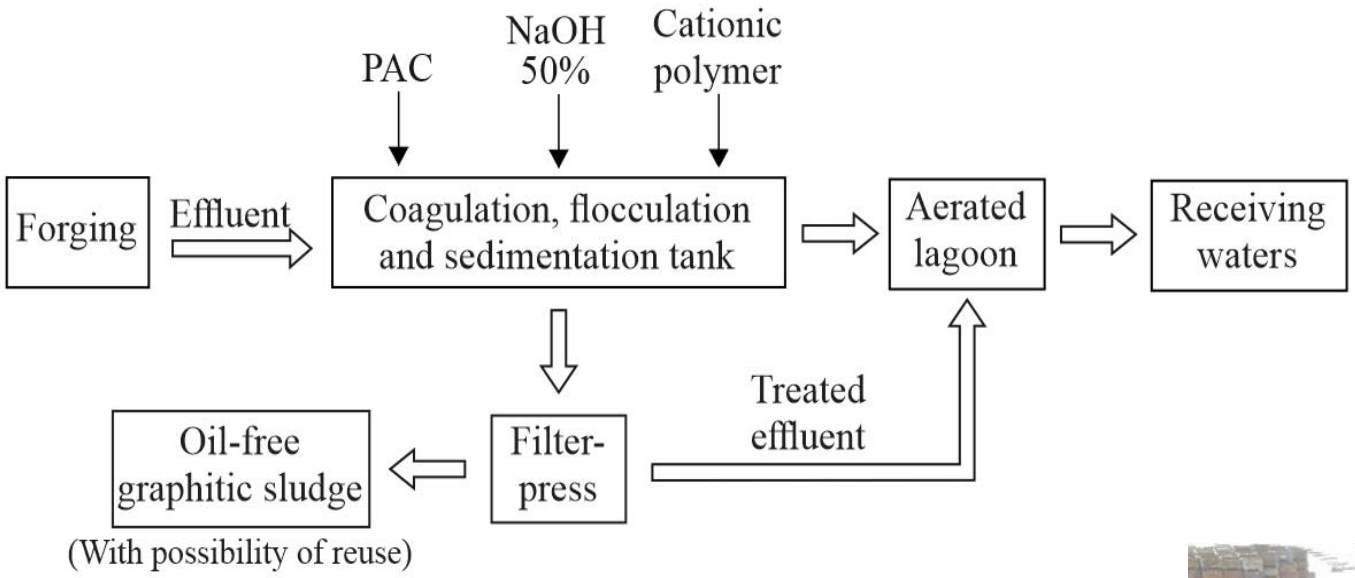
Purpose of this article is: studying the sludge generated from the treatment of the effluent using water-based lubricant. The sludge characteristics, its handling and final destination or reuse possibilities were assessed.

Materials and Methods

Physical-chemical characteristics of the water-based graphite lubricants

Parameter	Water-based lubricant
Color	Dark gray
Appearance	Homogeneous fluid
Graphite content	>=10%
pH of the emulsion	>=10
Density at 20 °C	1.1 g/cm³
Viscosity cSt at 40 °C.	1500 mPa.s
Average particle size	4 µm

Materials and Methods



Schematic representation of the steps of the treatment station.

Samples collected

Sludge Characterization

- Settled volume ASTM D3977;
- Specific mass according to ASTM D854,
- Moisture content ASTM D2216-10;
- Ash, volatile matter and fixed carbon content (ASTM D3172-07);
- Calorific value (ASTM D2015-00);
- Elemental analysis USEPA 3051ª , USEPA 3050B and ASTM D5373-02;
- Characterization regarding hazards according to the Standard NBR 10004.

- X-ray diffraction in a Siemens diffractometer model Kristalloflex D500;
- Electronic scanning microscopy and (EDS)
- Granulometric analysis with laser beam diffraction;
- Thermogravimetric analysis in a Thermobalance Netzsch STA.

Results and Discussion

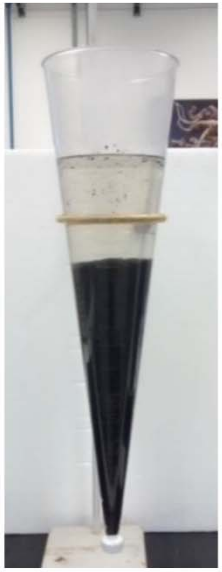
Parameters of the gross effluent treated with PAC and removal efficiency of the defined treatment

Parameter	Effluent		OL Standard	Efficiency (%)
	Raw	Treated		
DBO (mg/L)	6120	610	<= 110	90.0
DQO (mg/L)	16583	1650	<= 330	90.1
Total phosphorus (mg/L)	2	< LQ	<= 3.0	100
Total Kjeldahl nitrogen (mg/L)	295	160	<= 10	45.8
Suspended Solids (mg/L)	7870	12	<= 125	99.8
Sulfides (mg/L)	< LQ	< LQ	-	100*
Aluminum (mg/L)	163.1	0.188	-	99.9
Boron (mg/L)	50.6	39.2	<= 5.0	22.5
Lead (mg/L)	< LQ	0.102	-	***
Copper (mg/L)	1.25	0.093	<= 0.5	92.6
Iron (mg/L)	37.1	< LQ	<= 10	100*
Nickel (mg/L)	< LQ	0.017	<= 1.0	**
Zinc (mg/L)	1.35	< LQ	<= 2.0	100*
Oils and greases (mg/L)	300	< LQ	<= 10	100*
pH	9.63	6.40	6.0 – 9.0	-

* Measured value was below the quantification limit of the applied technique.

Sludge Characterization

Settled sludge after treatment in the Imhoff Cone (a); after filtration (b), after drying at 60oC and clod breaking (c); after compaction at 100 MPa (d).



(a)

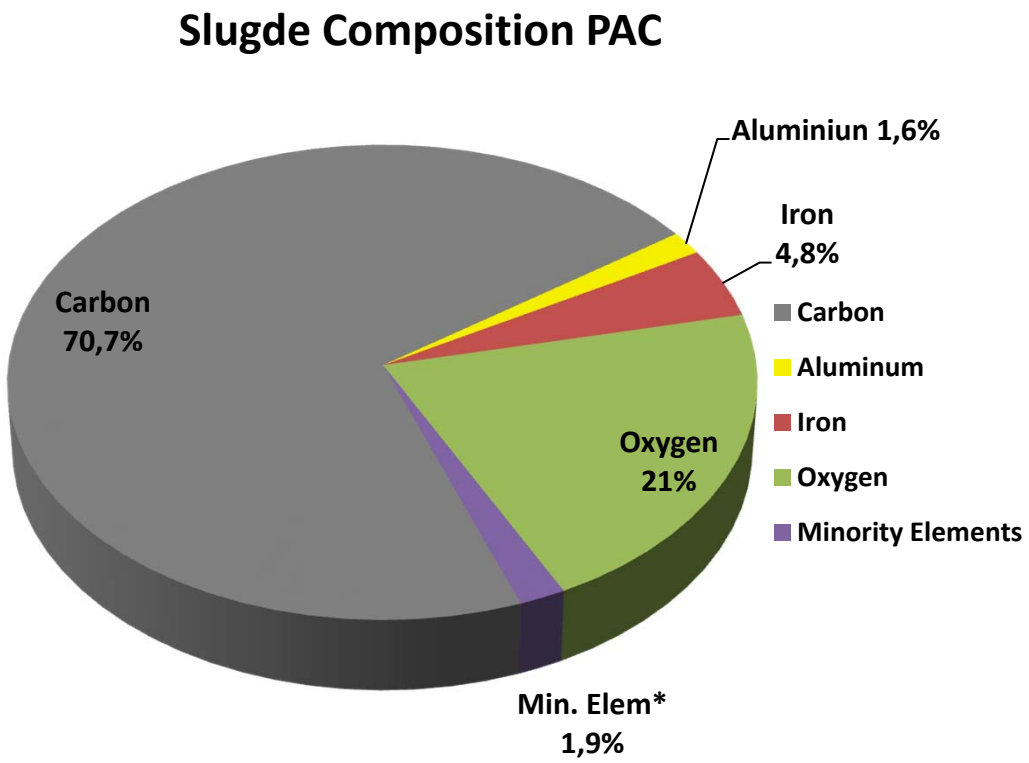
(b)

(c)

(d)

Sedimentation (1 hour) = 450 mL of sludge per liter of effluent (55% of the volume)
(24 hours) = 400 mL (60% of the volume of effluent in the clarified form).

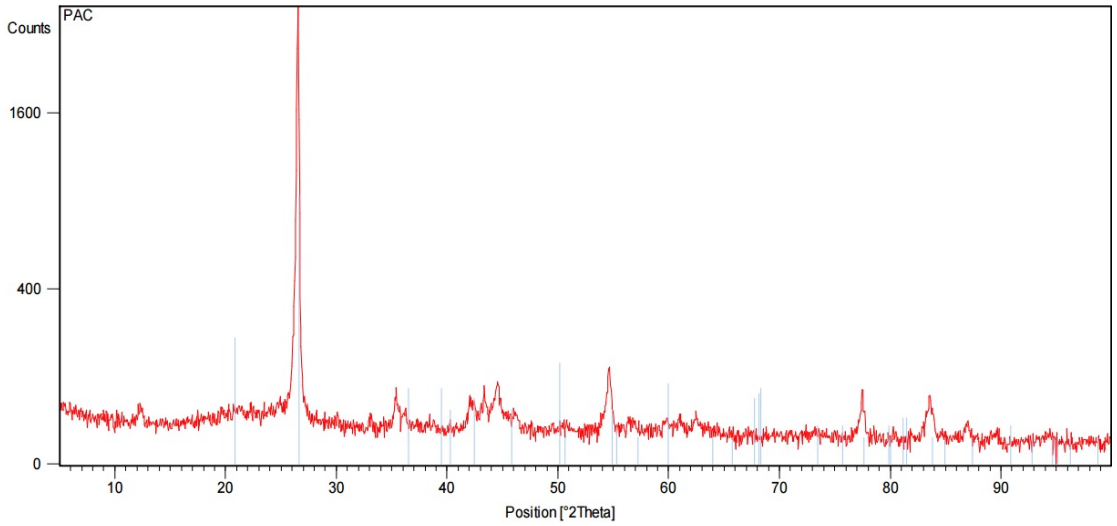
Sludge Elemental Analysis



CLASS II A WASTE - NON INERT

Sludge Characterization

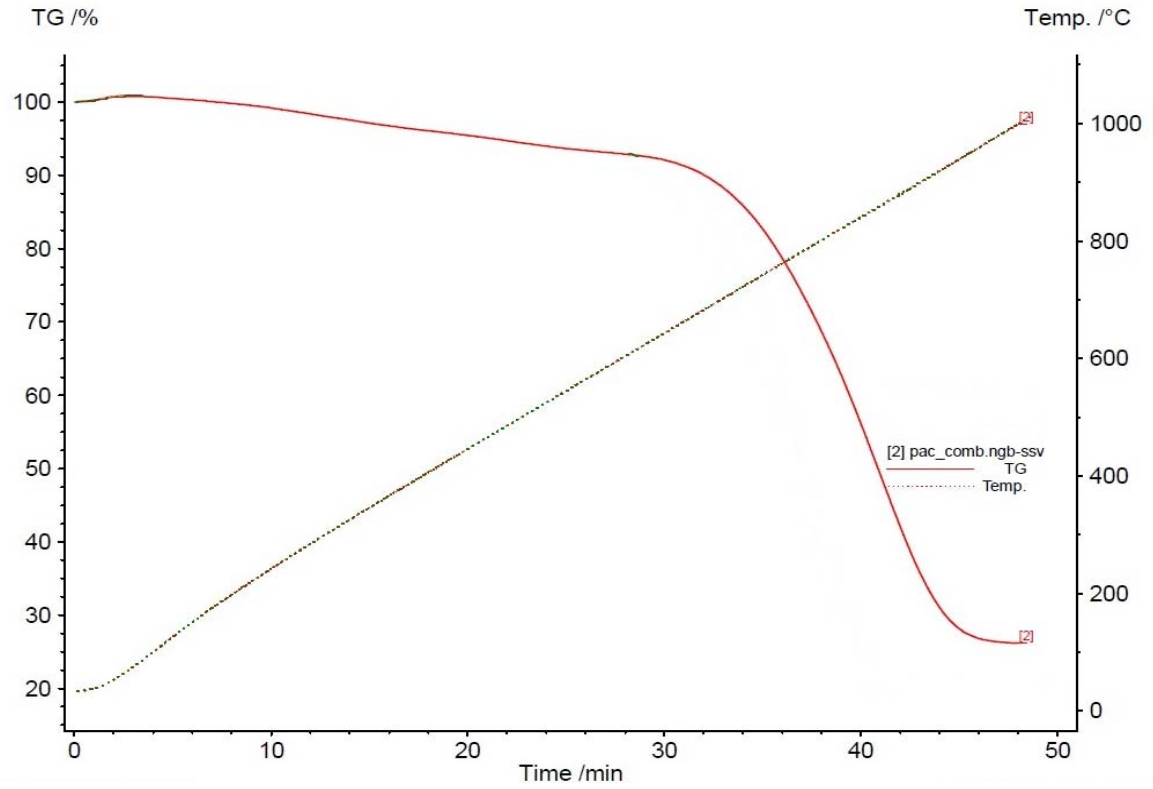
Diffractogram referring to the DRX analysis of the sludge generated.



Immediate analysis

	Water-based sludge
Calorific value (cal/g)	5850
Ashes (%)	21.4
Volatile matter (%)	9.0
Fixed carbon (%)	69.6

Thermogravimetric Analysis



Thermogravimetric analysis

Alternatives for sludge recycling

The change in lubricants from oil-based do water-based simplified the water treatment process, and generated a sludge that can be filtered, dried and compacted, reducing storage, transportation and disposal costs. The characteristics of oil-free sludge allowed sending to cement kilns, reducing partially the costs of destination.

After sludge characterization, other uses could be considered, including as co-fired combustible to coal thermal power plants.

Conclusion

Forging industries generate considerable amount of emissions, effluents and waste, requiring investments to prevent pollution and environmental damage. The treatment of effluents is a required operation. The use of water-based lubricants, replacing oil-based lubricants, improves the environmental performance. The change of lubricant enabled a sludge that can be easily filtered and handled. It presents a carbon content of 70% mainly in the form of graphite, with certain level of oxidation. In a regional context, it may be surely employed for power generating purposes in thermoelectric plants or cement kilns. However, other application alternatives are being investigated, including its cleansing and return to the lubrication process.

Acknowledgments

The authors are grateful for the financial support extended by GKN, CAPES and CNPq for this research.

Thanks/OBRIGADA