11-13 September / Eylül 2014
TÜYAP Fair, Convention & Congress Center, İstanbul
7th International Ankiros Foundry Congress
7. Uluslararası Ankiros Döküm Kongresi

«Greensand "Less Is Best": A More Sustainable Philosophy For Change»

«Yaş Kalıplama Tekniğinde Değişim İçin Daha Sürdürülebilir Bir Yaklaşım»

Brian Officer
(Amcol)

4.Oturum: Kalıp ve Maça Teknolojileri

4th Session: Mould & Core Technologies

Oturum Başkanı/*Session Chairman****: Dr. Türsen Demir (Çukurova Kimya End. A.Ş.)***

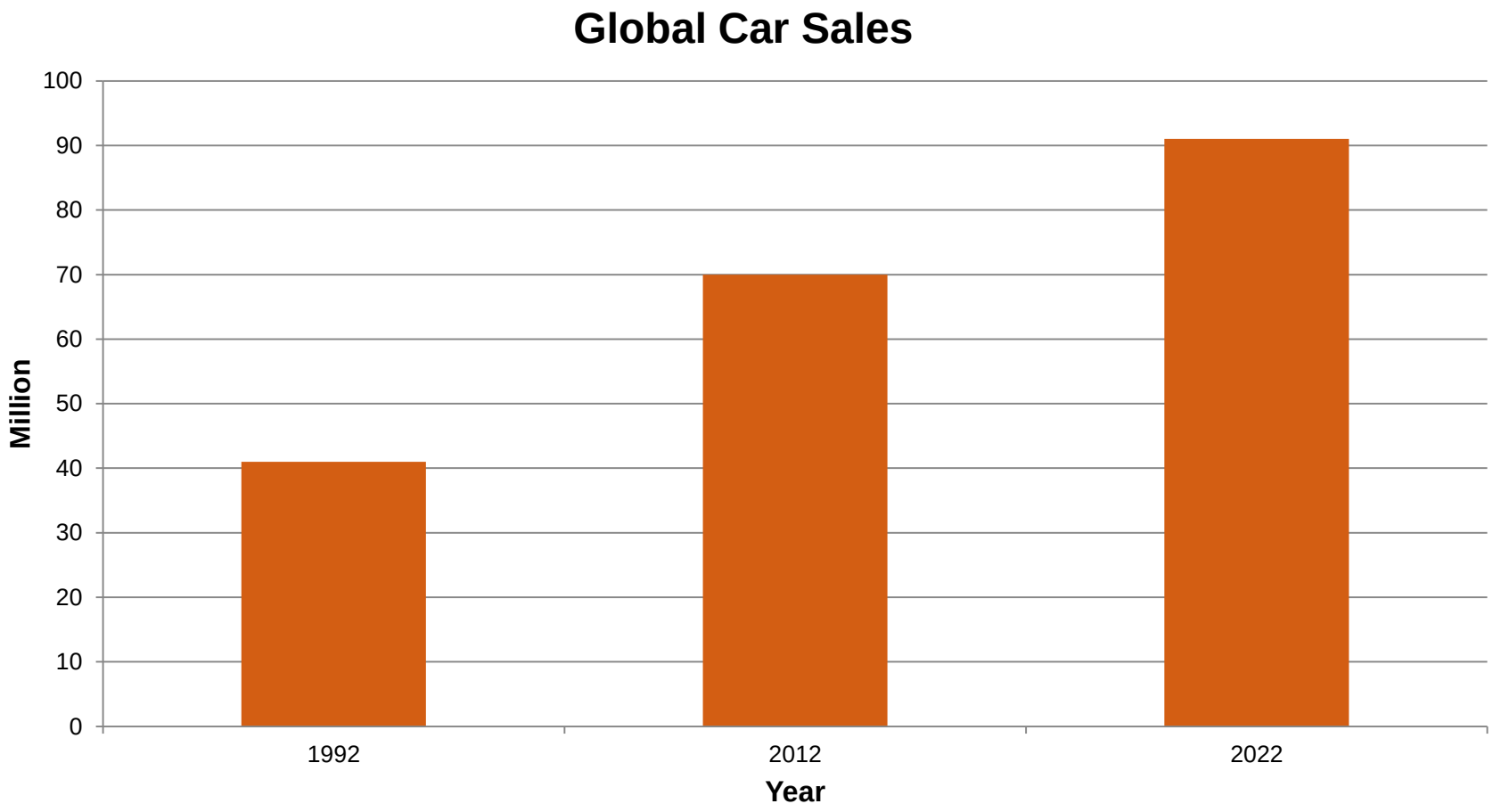
GREENSAND
"LESS IS BEST"
A MORE SUSTAINABLE PHILOSOPHY FOR CHANGE

AMCOL®
METALCASTING

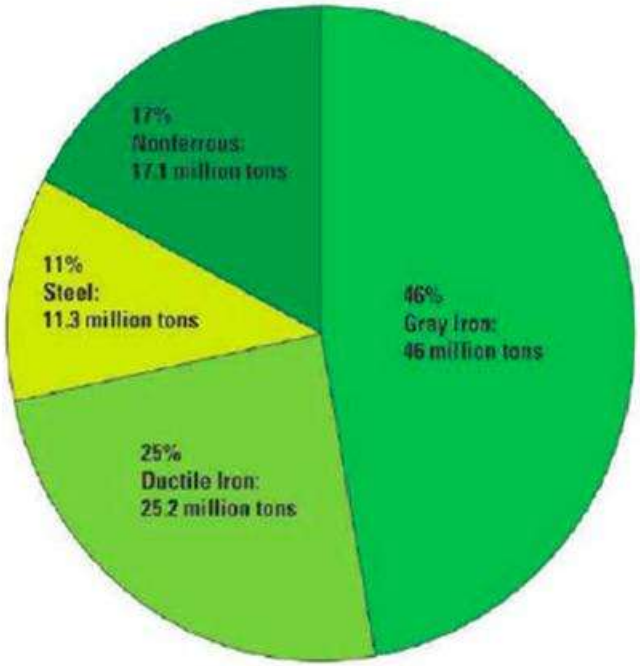
GREENSAND ADDITIVES

- Washed graded silica sand
- Calcium, Sodium or blended bentonite
- Coal Dust
- Lustrous carbon raiser (gilsonite, pitch)
- Premix Products

FERROUS CASTING OUTPUT



FERROUS CASTING MT PER ANNUM



FERROUS CASTING OUTPUT

- 70 MT/A GI and DI 70% produced in greensand
- 50MT/A castings
- 60% yield 5:1 sand : metal ratio
- 420 MT/A sand mixed
- 1% make up addition
- 4.2MT/A of additives

FERROUS CASTING OUTPUT

- IN ORDER TO PRODUCE BENTONITE AND CARBON PRODUCT
- Mining
- Crushing
- Activation
- Drying
- Shipping
- A LOT OF ENERGY CONSUMPTION

GLOBAL GREENSAND SYSTEM PROPERTİES TYPİCAL VENTİLATED DİSC FOUNDRİES

Table 1. Typical Regional Greensand Property

Properties	China	India	Australia	Europe	USA
Compactability %	34-36	35-39	34-36	35-37	36-38
Active clay %	9.0-10	10.0-11.0	8.5-9.5	9.0-10	7.5-8.5
Volatile %	2.5-2.7	3.0-3.3	1.3-1.5	1.8-2.0	1.5-1.7
LOI %	4.2-4.6	5.0-5.5	2.8-3.0	3.4-3.8	2.8-3.1
Wet Tensile N/cm2	0.33-0.35	0.18-0.22	0.21-0.24	0.32-0.34	0.29-0.33
Moisture%	3.3-3.6	3.5-3.8	3.0-3.2	2.9-3.2	2.8-3.0
Green Strength N/cm2	20-22	18-21	22-24	23-25	22-24
Permeability	120-140	130-150	70-80	120-130	110-130
Total Clay%	12.0-13.0	13.0-14.5	11.0-12.0	11.5-12.5	10.0-11.0
Afs no.	56-60	55-60	65-70	61-65	60-63

REGİONAL BENTONİTE PROPERTİES

Table 3. Foundry Bentonite Properties

Origin	China	India	Australia	Europe	USA
CEC (meq)	88	96	74	84	108
Total Hardness	9	16	7	14	20
Soluble Ca CO3 (%)	4.25	3.2	1.2	3	2.6
PH	9.6	9.64	9.9	9.3	9
Free Swell (mls)	23	23	28	28	34
Grit (%)	2.6	2.2	3	2.7	2.6
Silica sand +Clay (%)	7	7	7	7	7
MOISTURE (%)	2.7	2.2	2.2	2.3	2.6
WATER (mls)	75	75	53	70	80
COMP (%)	41	40	39	40	40
PERM	160	130	167	165	145
GCS (psi)	13	19	12.7	15.9	14.1
DCS (psi)	32	38	30	37	37
GS (psi)	2.7	3.2	2.3	3	2.9
WTS (n/cm2)	0.27	0.48	0.23	0.30	0.25

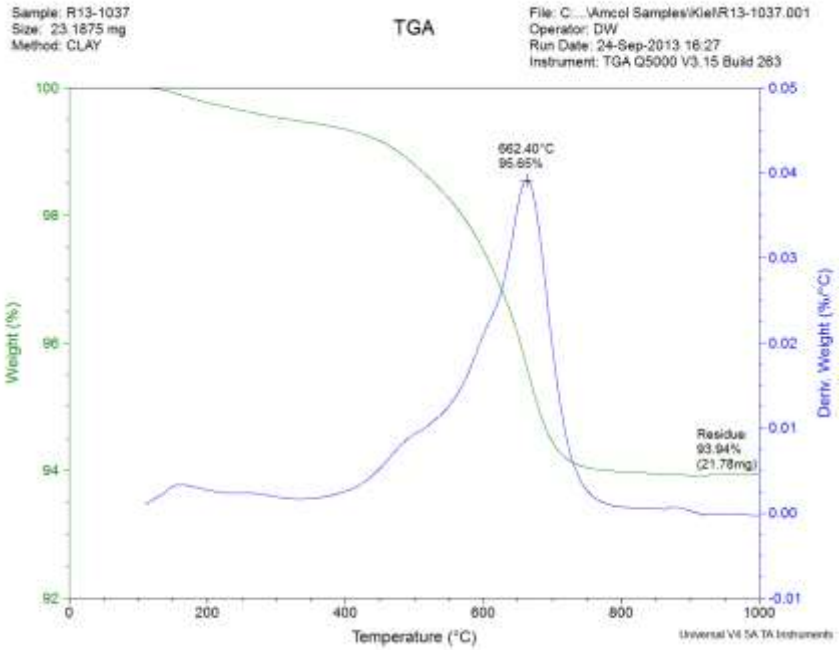
GLOBAL GREENSAND ADDİTİVES AND ADDİTİONS TYPİCAL VENTİLATED DİSC FOUNDRİES

Table 2. Typical Regional greensand Additions

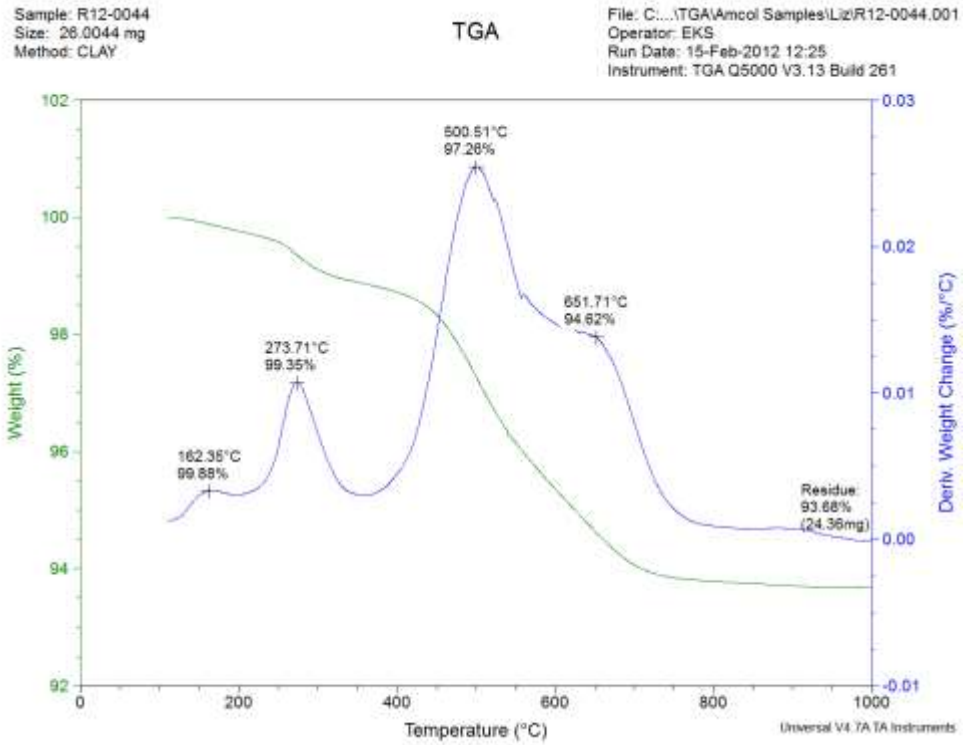
Additions	China	India	Australia	Europe	USA
Bentonite Na					
Bentonite activated Ca	✓	✓		✓	
Blended bentonite			✓		✓
Coal	✓	✓	✓	✓	✓
Pitch		✓			
Lustrous carbon raiser	✓		✓	✓	
Modified lignite					✓
Cereal	✓				
Wood flour		✓			
Typical make up add %	1	1.3	0.7	0.75	0.5

THERMAL GRAVIMETRIC ANALYSIS (TGA)

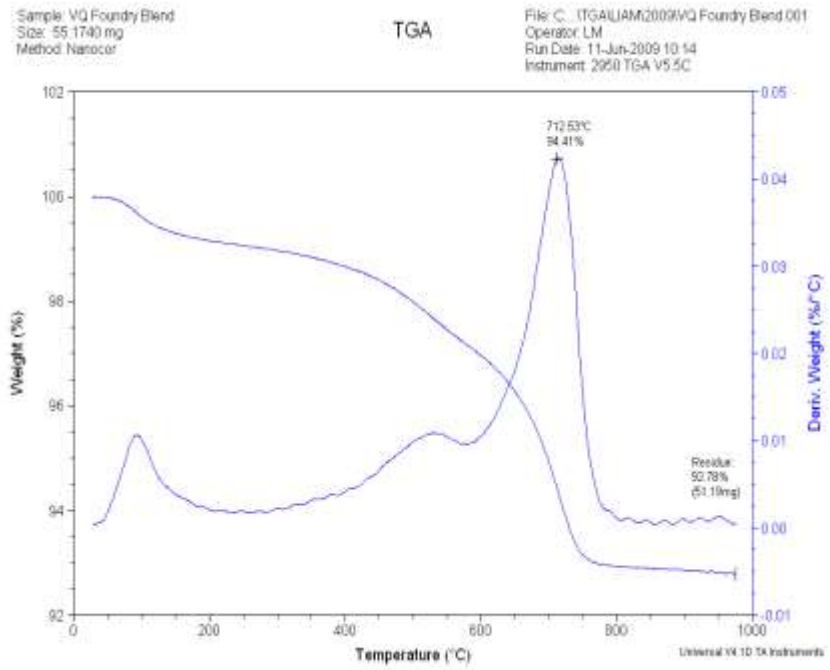
CHINESE BENTONITE



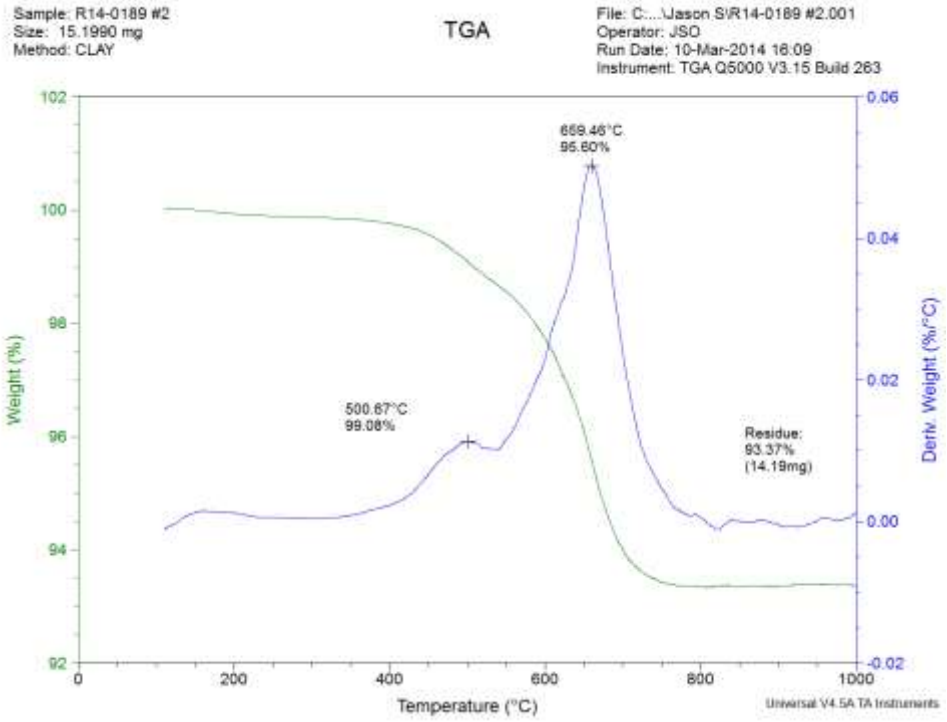
INDIAN BENTONITE



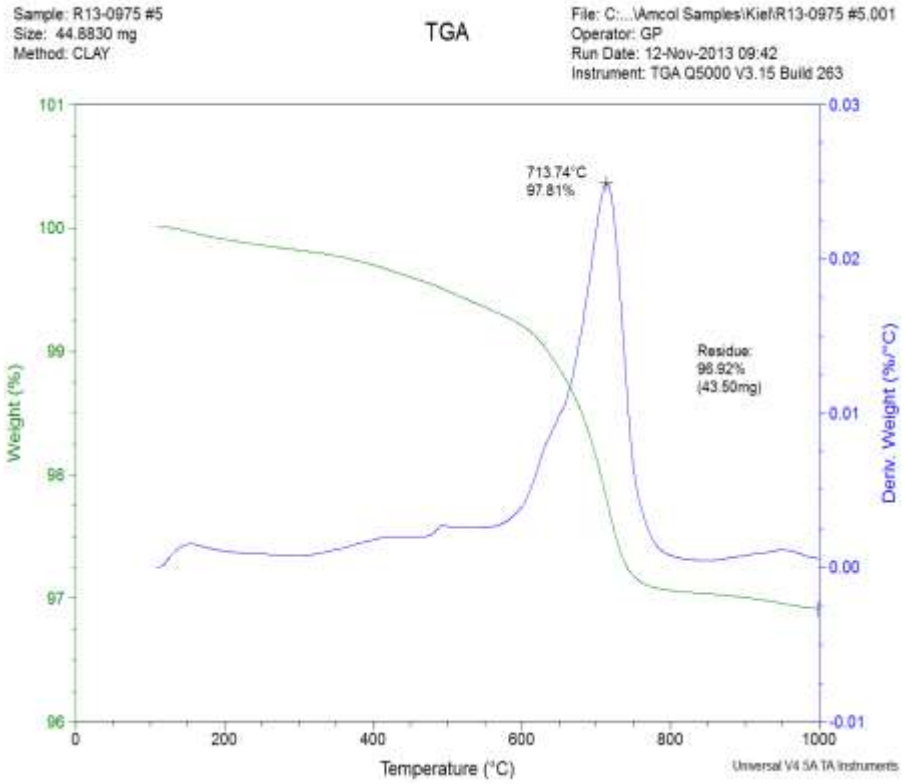
AUSTRALIAN BENTONITE



EUROPEAN BENTONITE



USA BENTONITE

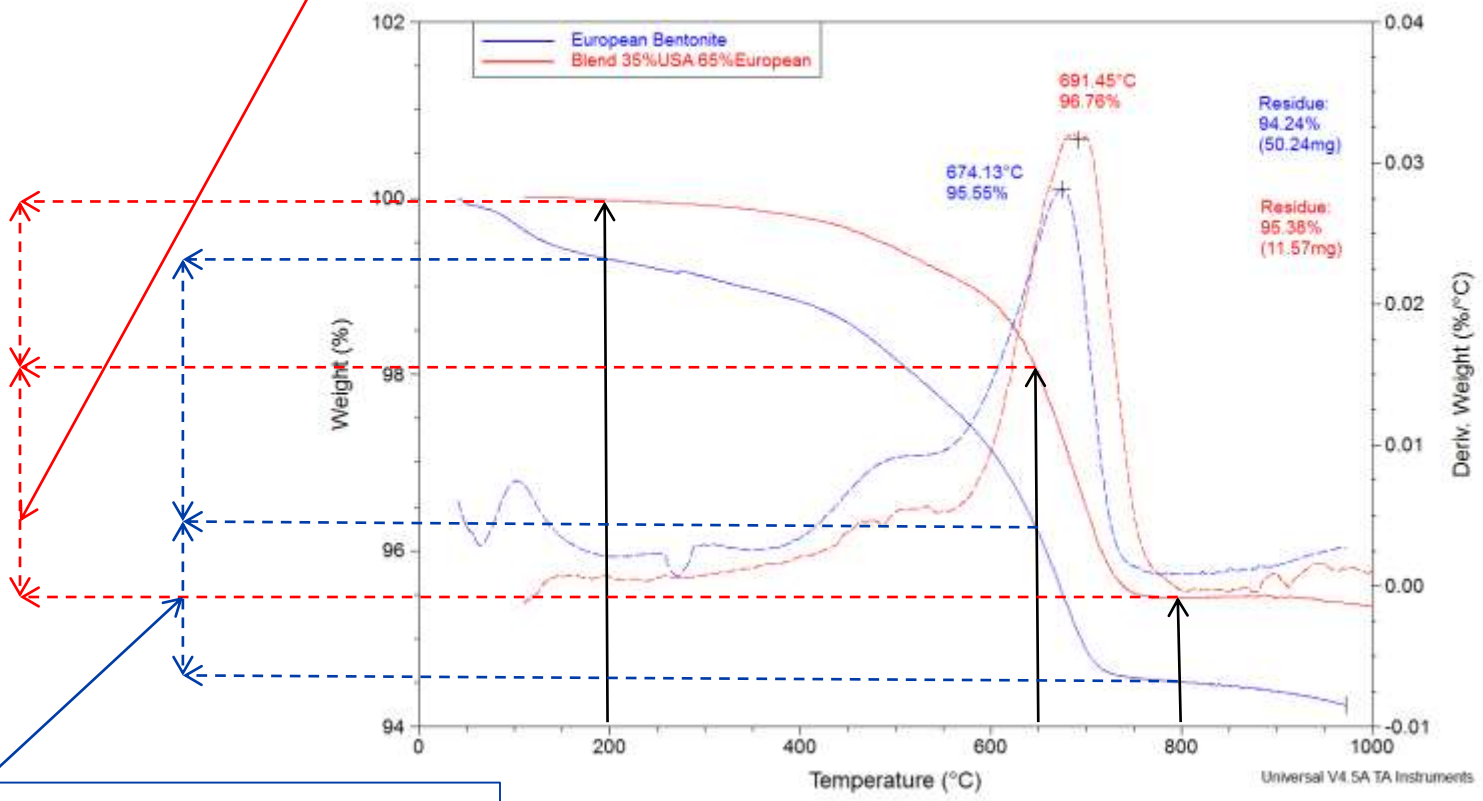


UNACTIVATED AND ACTIVATED SODIUM BENTONITE

ACTIVATED EUROPEAN AND 20% UNACTIVATED USA BENTONITE + 80% ACTIVATED EUROPEAN BENTONITE

EFFECT OF BLENDING USA BENTONITE WITH CALCIUM BENTONITE

65% RETAINED



40% RETAINED

CARBONACEOUS ADDITIVES

- Coal dust

  pitch

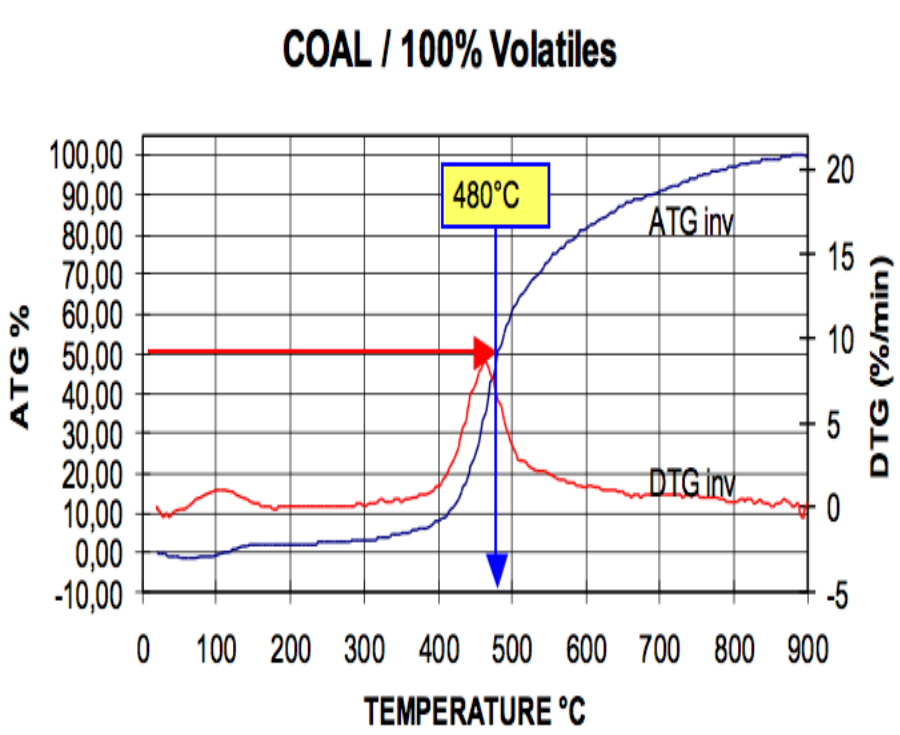
  asphalt

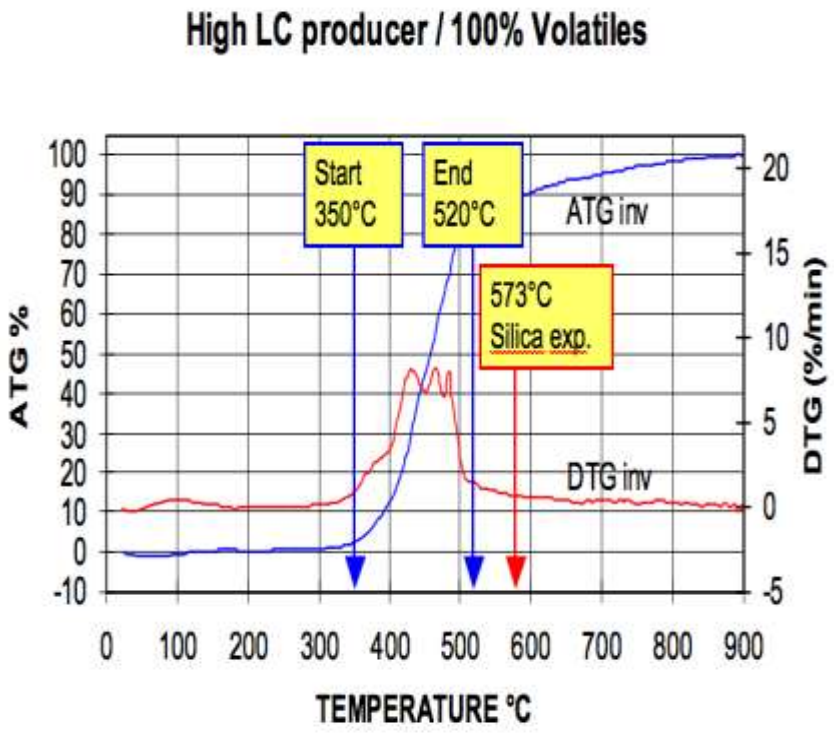
  gilsonite

  starch

  lignite

TGA CARBONACEOUS PRODUCTS

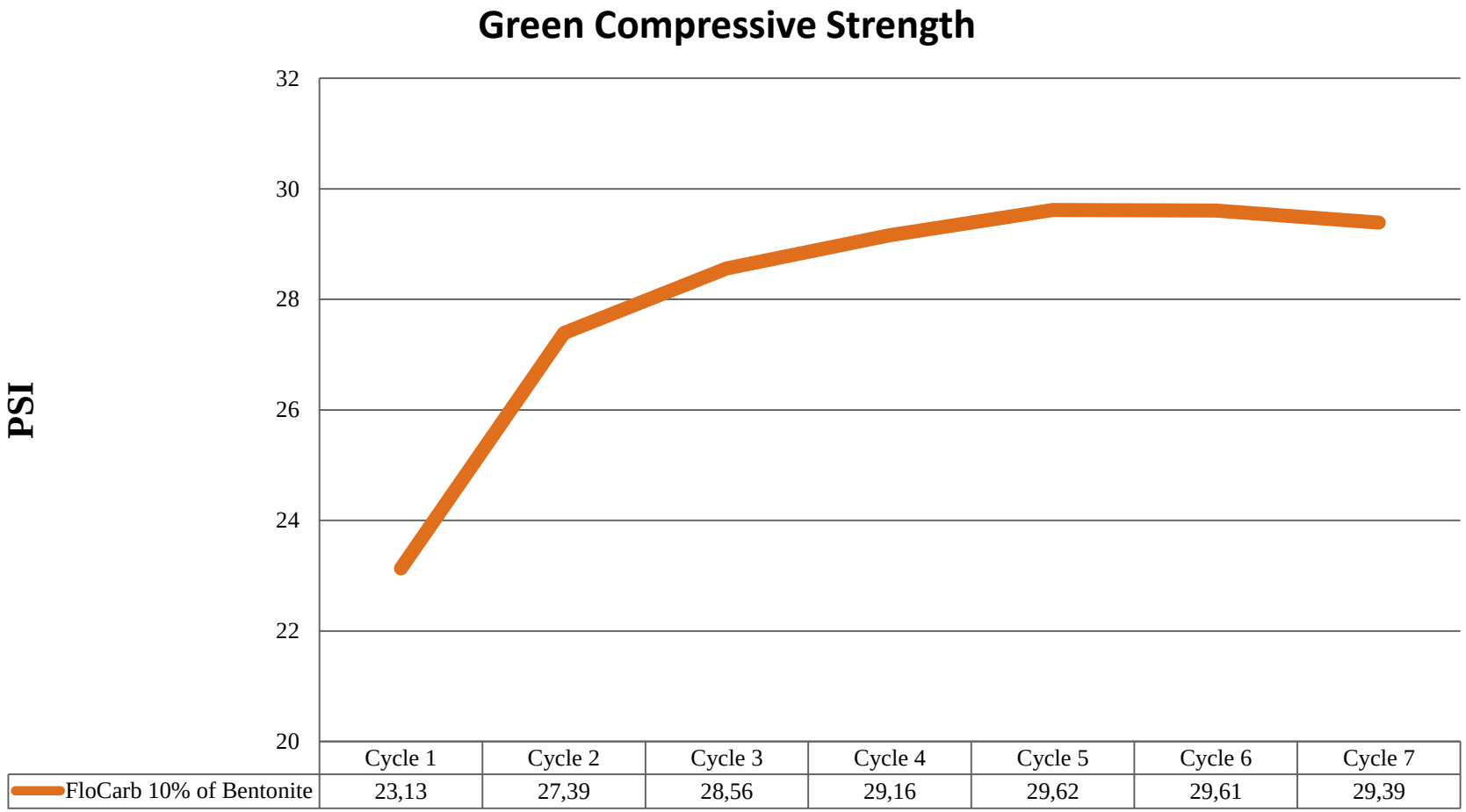




Lignite – Influence on system sand properties with pouring cycles

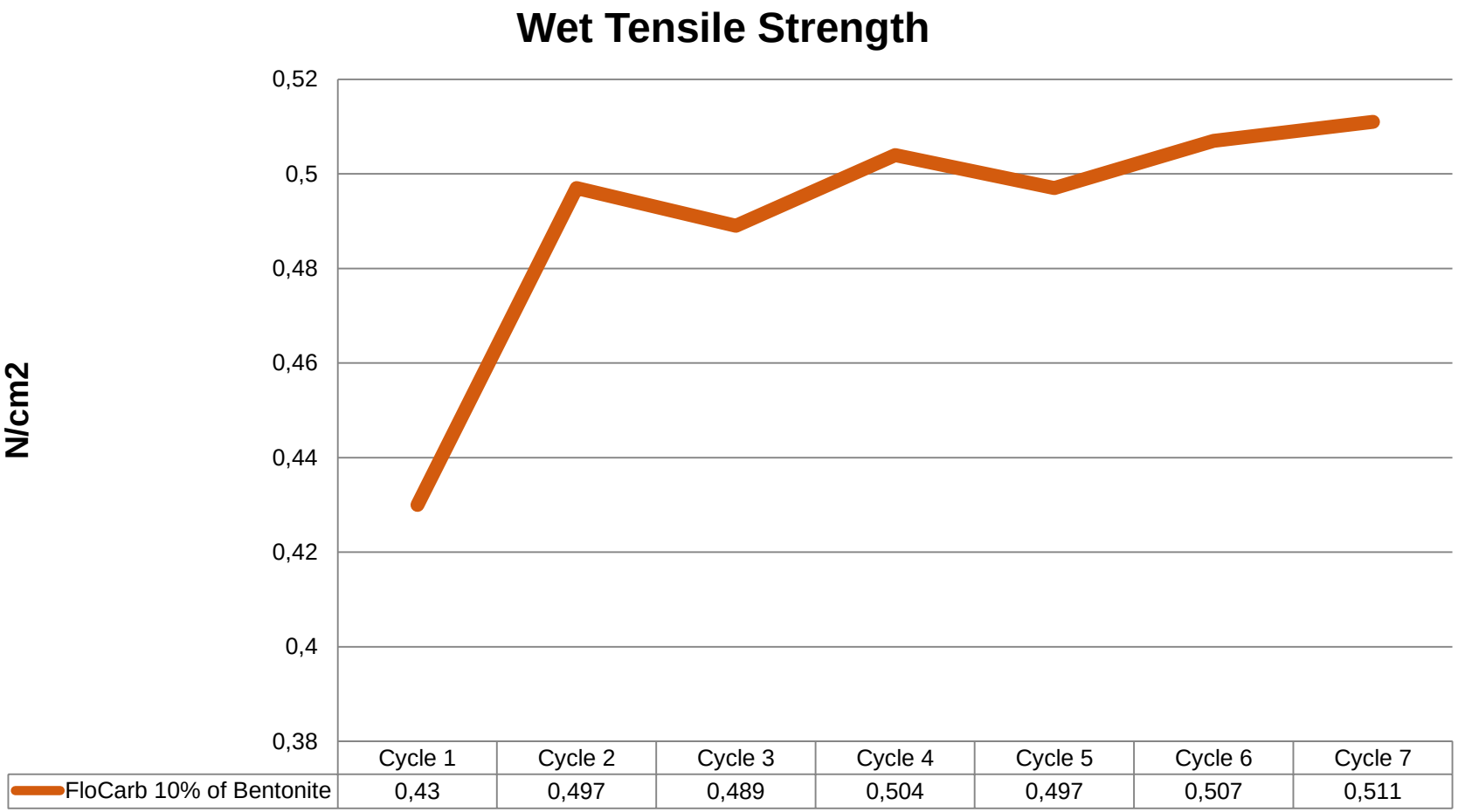
- The experiment design was as follows
  - Simpson 500 Kg Muller – mixing time 10 min
  - Silica Sand (Wedron 520)
  - 8% Sodium Bentonite
  - Carbonaceous additives – 20% of dry Bentonite weight
    - Seacoal – 10% of Bentonite
    - Lignite – 10% of Bentonite
  - Herman High Pressure Moulding machine – B Scale Hardness 92 – 95
  - Compactability target 39
  - 7 Complete casting cycles - maintaining Clay, CB and combustible materials. 3 moulds poured for each cycle

GCS increases after one cycle, indicating the Lignite impacting on the Bentonite properties



	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7
FloCarb 10% of Bentonite	23,13	27,39	28,56	29,16	29,62	29,61	29,39

WTS shows a similar trend to GCS – reflecting the Lignite impacting on the Bentonite



	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7
FloCarb 10% of Bentonite	0,43	0,497	0,489	0,504	0,497	0,507	0,511

Lignite – Influence on HAPS

- In 2004, an emission test study was conducted to determine the effect of using FloCarb as a Seacoal replacement for green sand moulding
- The study and testing were conducted by,
  - University of Northern Iowa, Cedar Falls, IA
  - AFS – American Foundry Society
  - ACC – American Colloid Company

Testing Summary

- The greensand mixtures consisted of the same silica sand, 8% Sodium Bentonite and Carbonaceous additive of 20% of the Bentonite dry weight.
- 4 Recipes where used to compare the effects of substituting Seacoal with Lignite
  1. 100% Seacoal
  2. 75% Seacoal – 25% Lignite
  3. 50% Seacoal – 50% Lignite
  4. 100% Lignite

Testing Methodology

- The same pattern was used for each testing.
- 3 moulds were produced from each sand batch, and each recipe was cycled 7 times to mature the mix
- The emission testing was conducted on Cycles 6 & 7.
- The same metal composition and process used for all tests

Testing Methodology

- The emission testing during the casting process remained at constant time for all the test
  - Pouring – 0 to 5 minutes
  - Cooling – 5 to 65 minutes
  - Shakeout – 65 to 70 minutes
- The emission samples were collected and tested by an independent laboratory

Reduction of HAPS and VOC – 45% Reduction

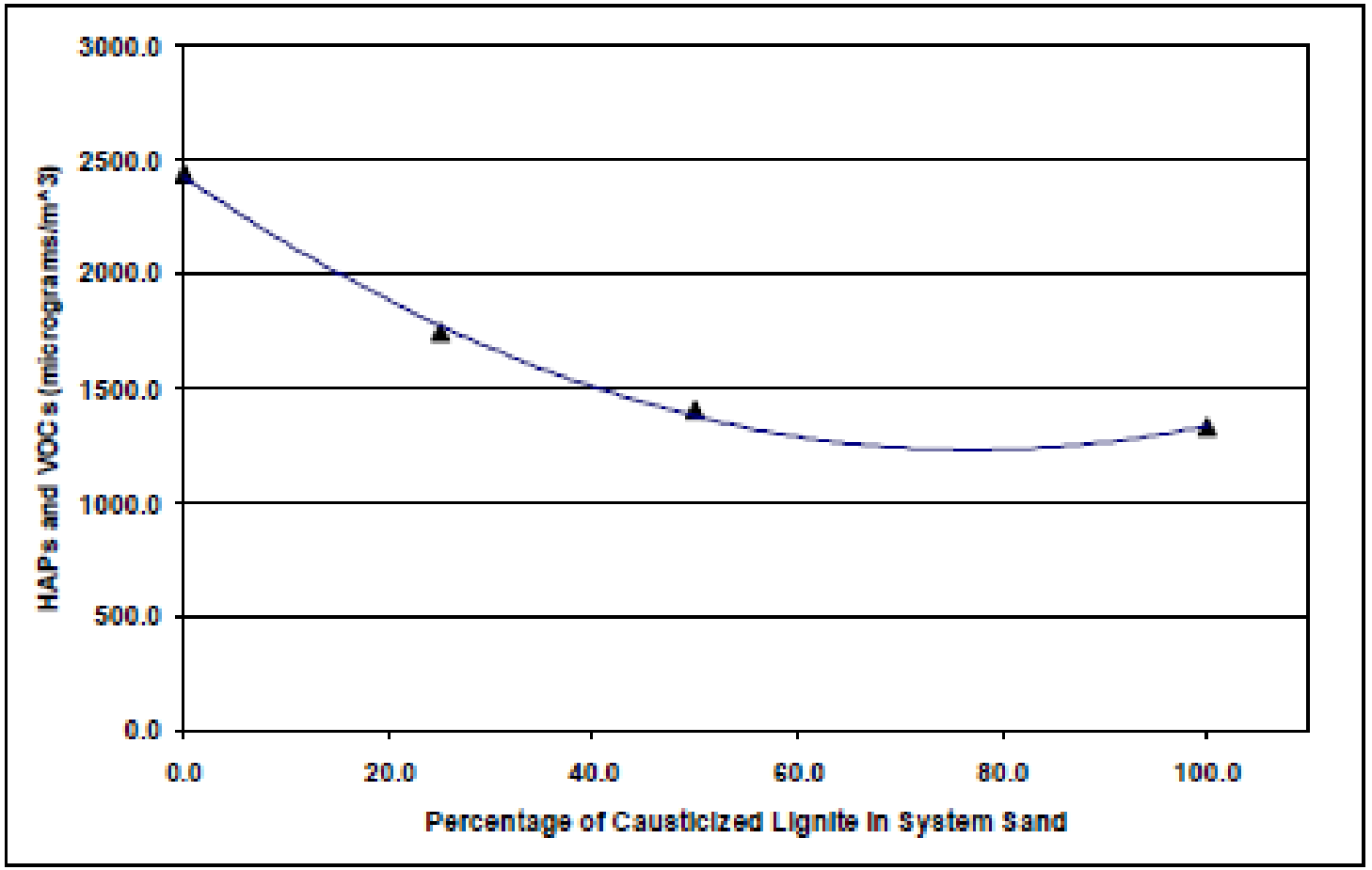


Fig. 4: Reduction of HAP and VOC Emissions as a Function of the Seacoal: Causticized Lignite Ratio

Total Benzene Emissions – 42% Reduction

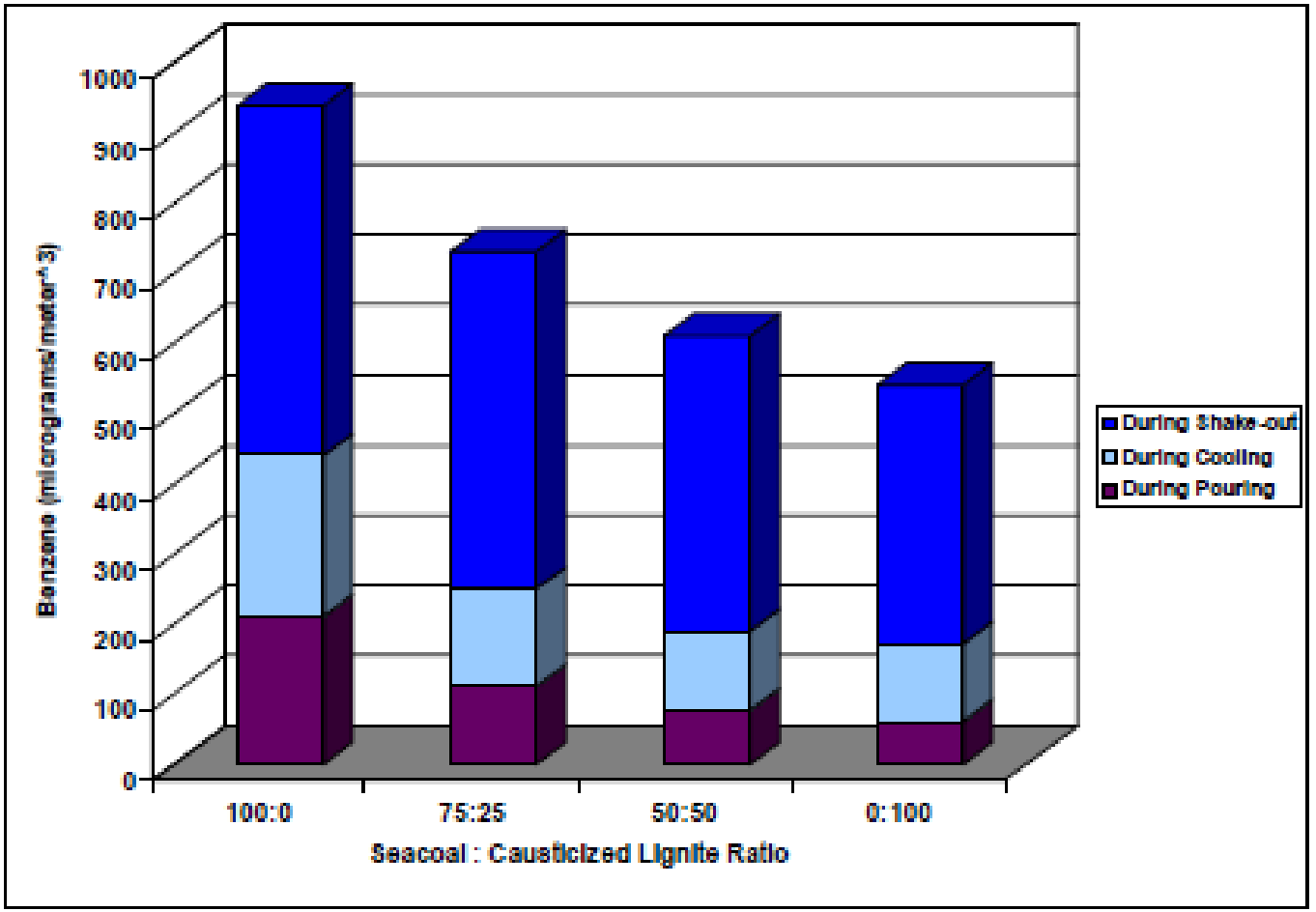


Fig. 5: Total Benzene Emissions as a Function of the Casting Process (µg/m³)

Toluene Emissions – 54% Reduction

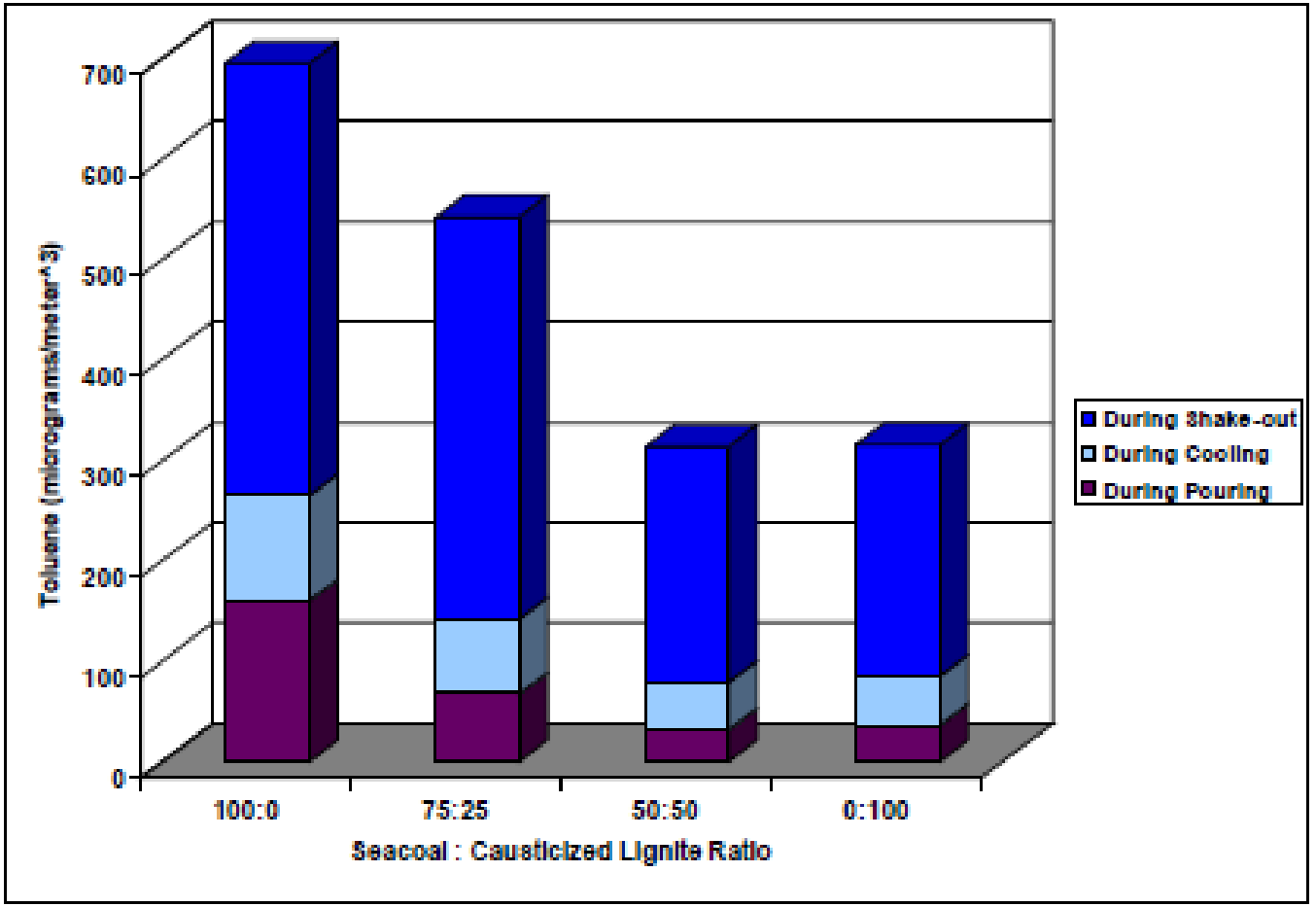
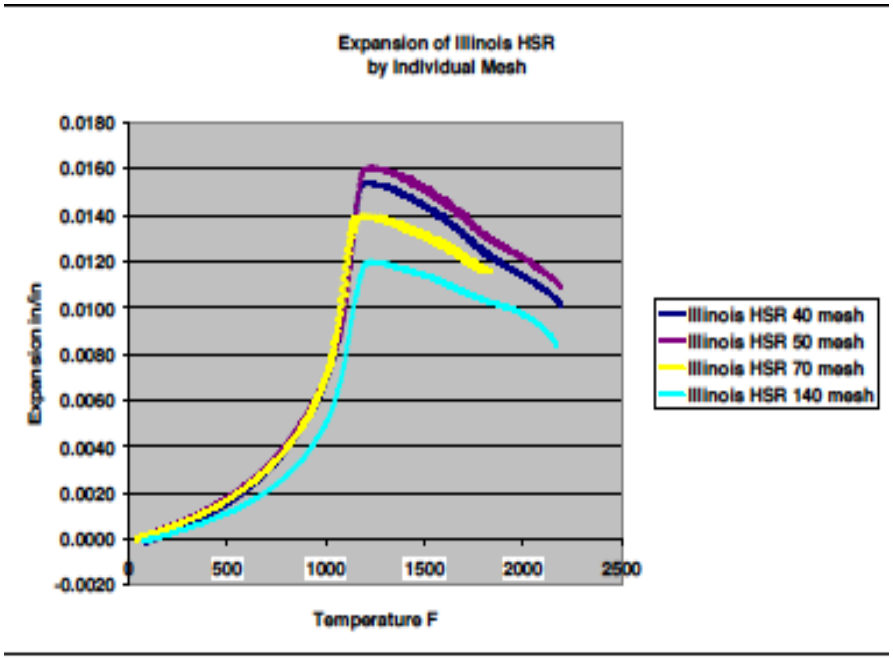
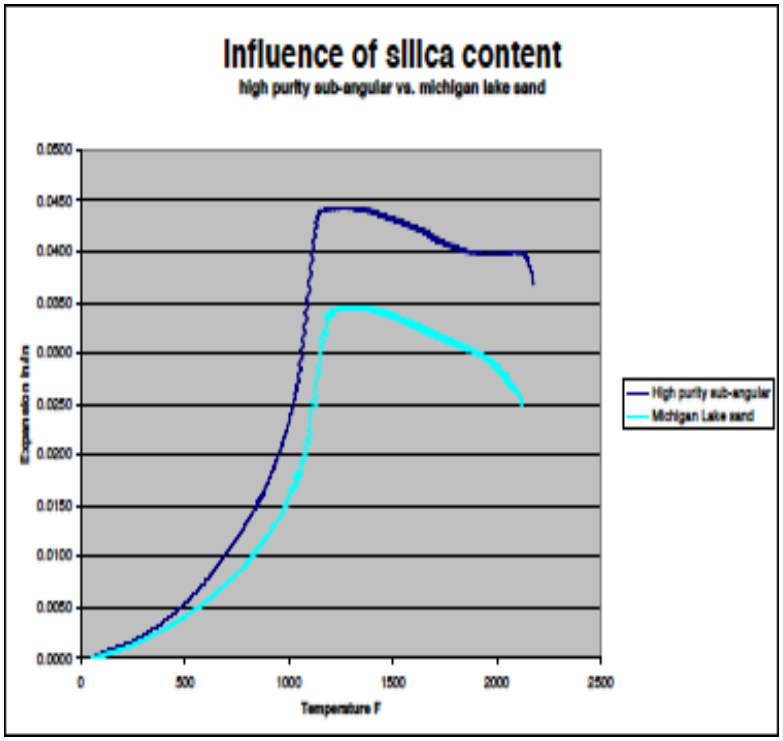


Fig. 6: Total Toluene Emissions as a Function of the Casting Process (µg/m³)

SILICA SAND EXPANSION





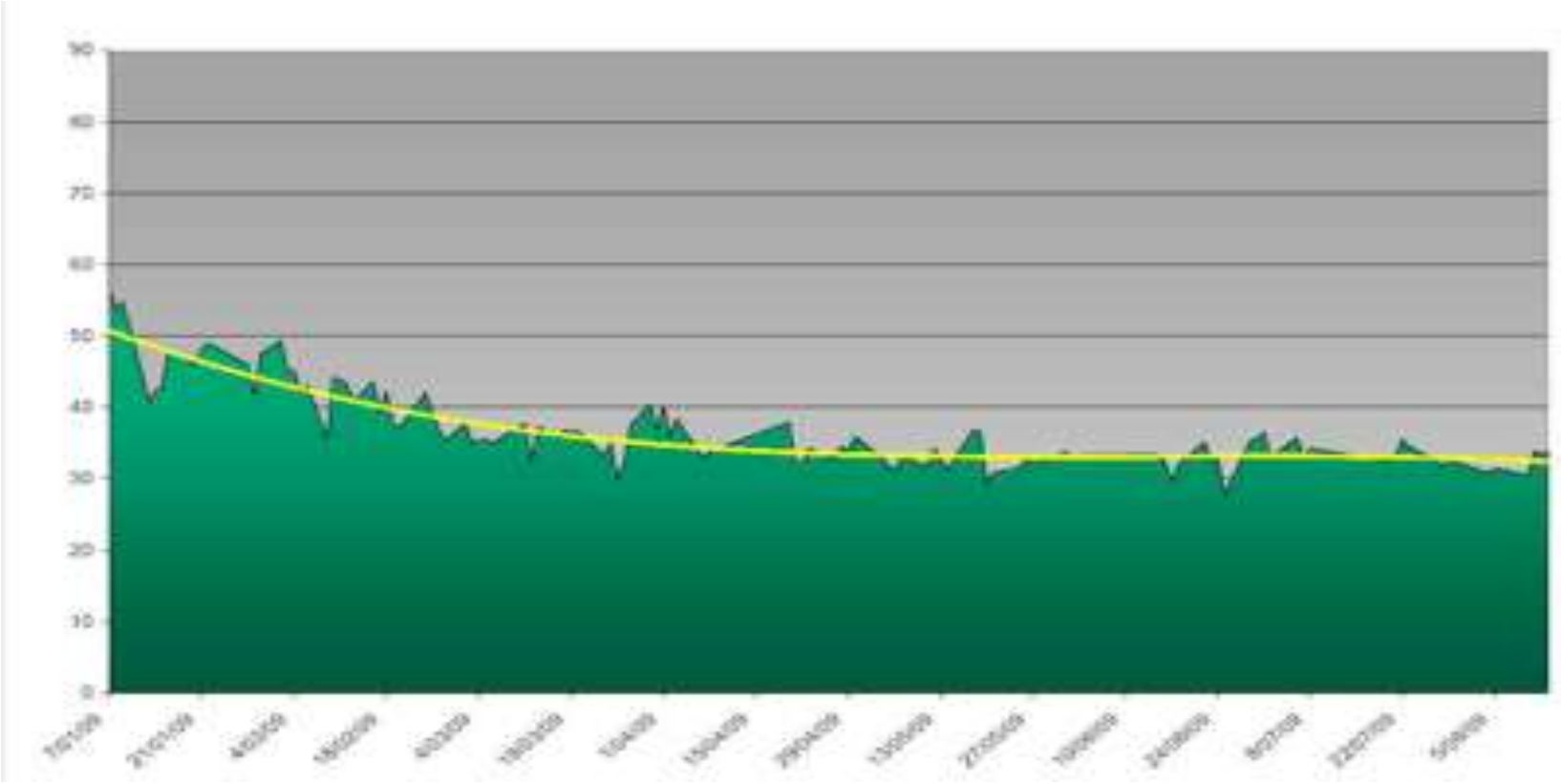
HOT STRENGTH DATA

	USA (psi)	European (psi)	Australian(psi)	Chinese (psi)	Indian (psi)
Temperature (°C)					
900	510	370	435	400	220
1010	595	175	510	190	95
1100	192	35	123	40	18

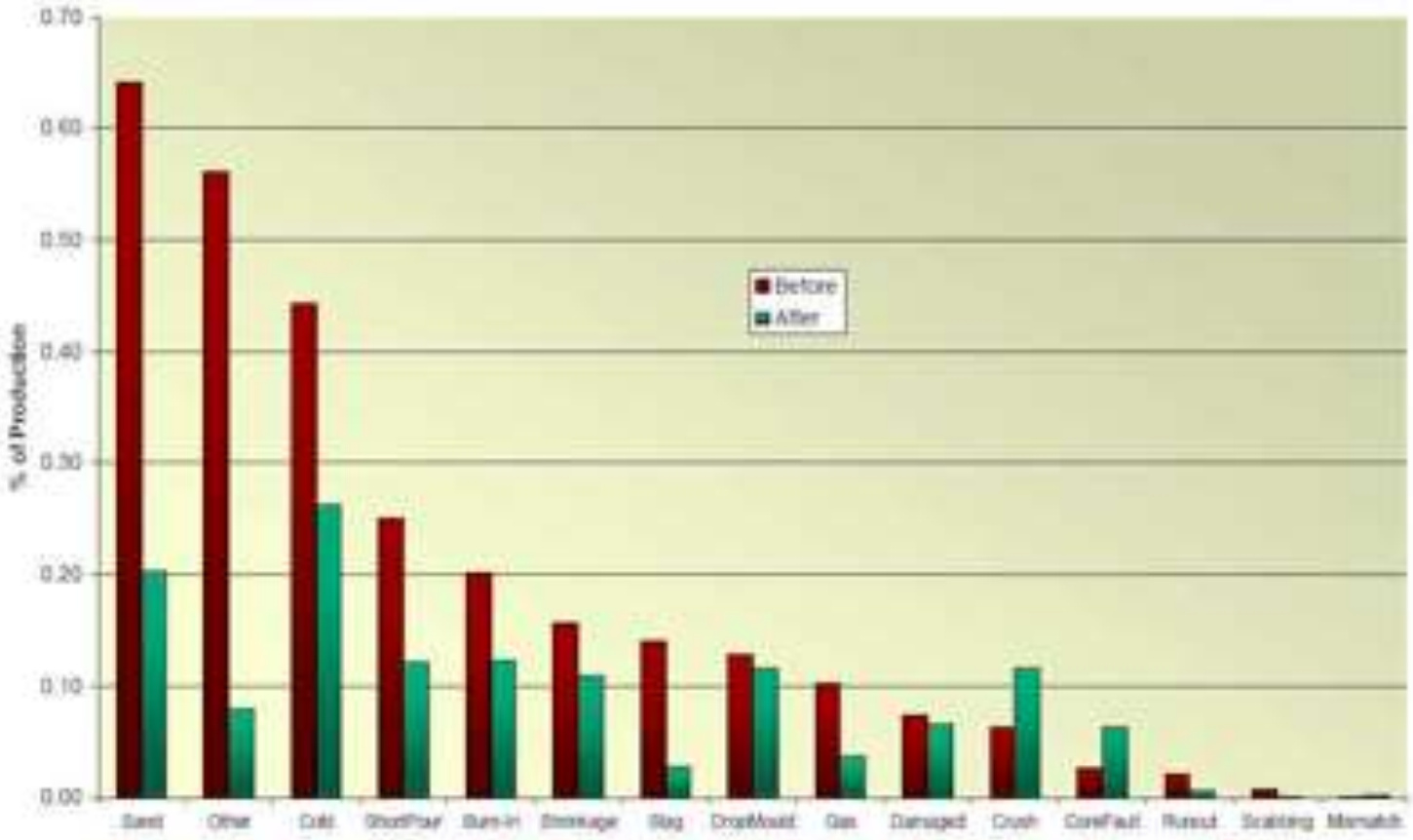
LESS IS BEST I+F TRIALS

- The main problems were-:
- Inclusions and poor compaction in pockets
- Overloaded sand system
- Objectives -:
- Reduce defects, reduce consumption and emissions, reduce unit costs.

I+F RAW MATERIAL USAGE

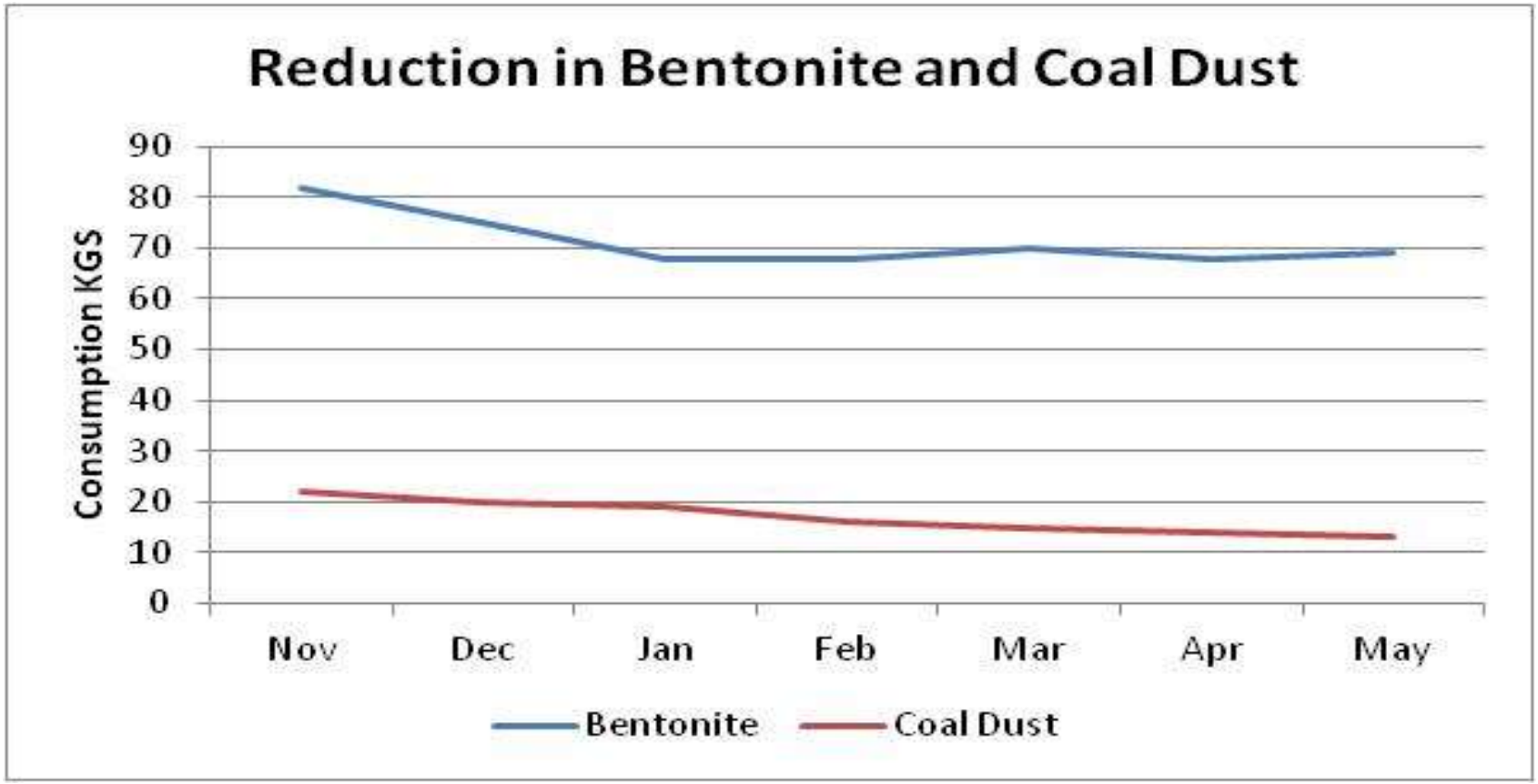


I+F SCRAP ANALYSIS BEFORE AND AFTER



TYPICAL I+F CASTING SURFACE BEFORE AND AFTER

LESS IS BEST - ADDITION RATES UK FOUNDRY



LESS IS BEST – UK FOUNDRY – SAND PROPERTIES BEFORE AND AFTER

Active Clay (%)	AFS clay (%)	Volatile (%)	LOI (%)
11	15.5	2.6	6.9
11	12.5	1.6	4.7

Moisture (%)	GCS (psi)	Permeabilty	WTS (n/cm2)	DCS (psi)	Compactibility (%)
5	25.7	104	0.32	42	40
4	23	115	0.3	52	40

LESS IS BEST – TURKISH FOUNDRY– SAND PROPERTIES BEFORE AND AFTER

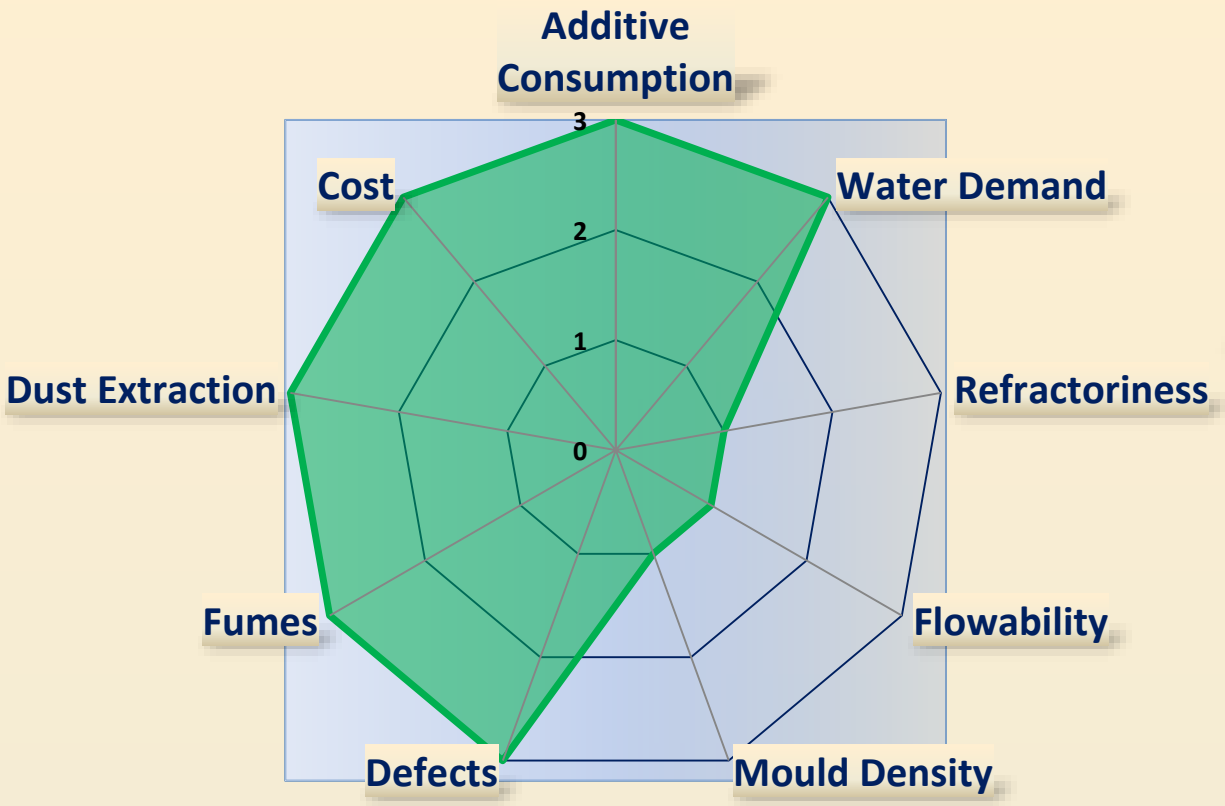
Active Clay(%)	*AFS Clay(%)*	*Volatile(%)*	*LOI(%)*
11.2	*20.1*	*2.6*	*8.1*
8.4	*13.7*	*1.9*	*5.7*

Moisture(%)	*GCS(kn/m2)*	*WTS (n/cm2)*	*DCS (kn/m2)*	*Comp (%)*	*Sample Wgt (g)*
4.6	*174*	*0.29*	*560*	*42*	*141*
4.2	*158*	*0.25*	*597*	*43*	*143*

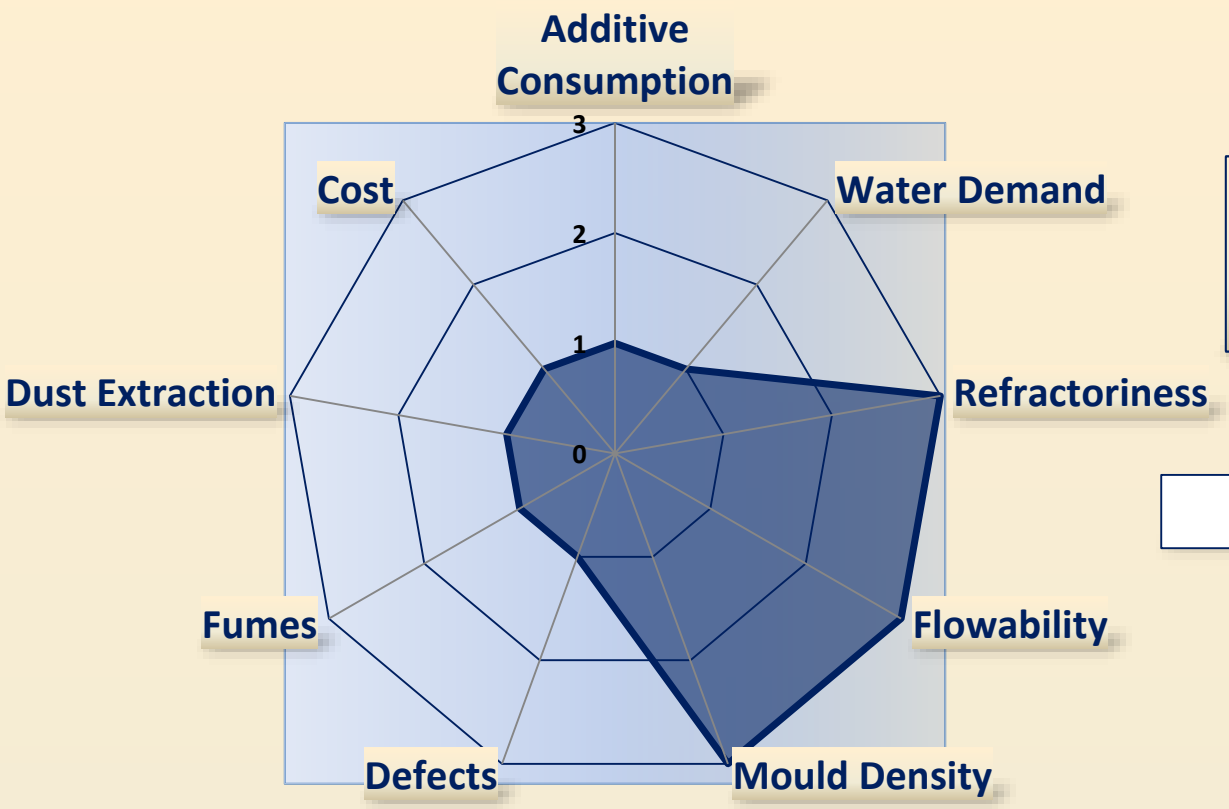
LESS IS BEST – TURKISH FOUNDRY– MATERIAL USAGE BEFORE AND AFTER

Bentonite (kg)	Coal(kg)	New Sand (kg	Bent/Metal	Bent/NS	Bent / burn out	% Bent Reduction
15	15	20	13.5	1.98	11.5	
Maxicarb						
11	0	20	8	1.98	6	
						47%

Less Is Best - Effect of High Additive additions



Less Is Best - Effect of Low Additive additions



CONCLUSIONS – LESS IS BEST

- Selection of bentonite and carbon additives should based on high temperature criteria as opposed to room temperature data
- Global experience from foundry trials
- Foundries should be able to

CONCLUSIONS

- Significantly reduced consumption of make up additions to greensand systems.
- Significantly reduce the emission of HAPS
- Reduce or remove the risks of fires and explosions both in transportation and storage.
- Improve mold face stability and reduce the incidence of sand related defects.
- Reduce the total carbon footprint associated with the mining, processing, transporting and use and disposal foundry sand system raw materials.