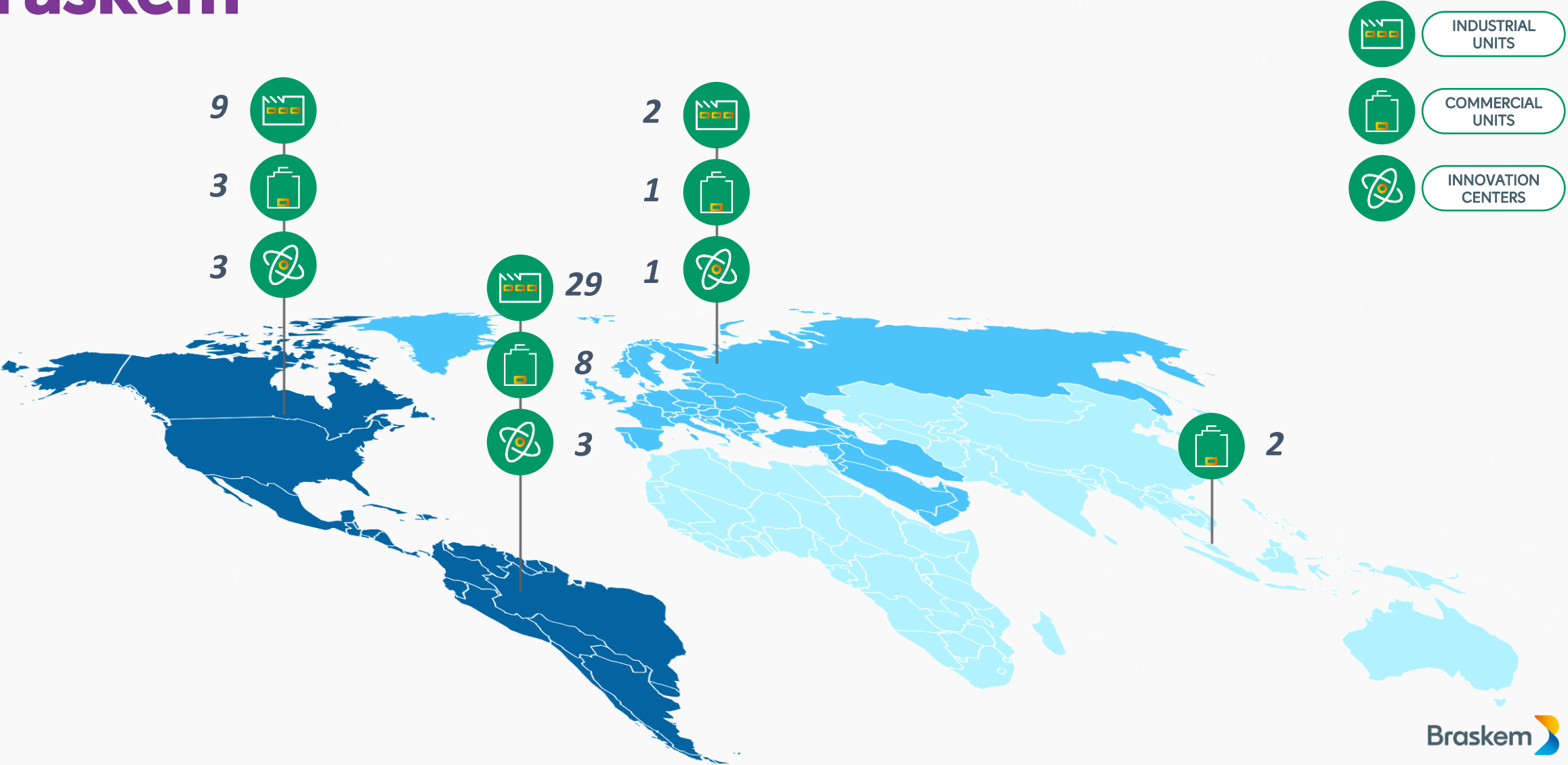




**Polyisobutene as a Solution in**  
**Industrial Lubricants:**  
*Application in Sugarcane Mills*



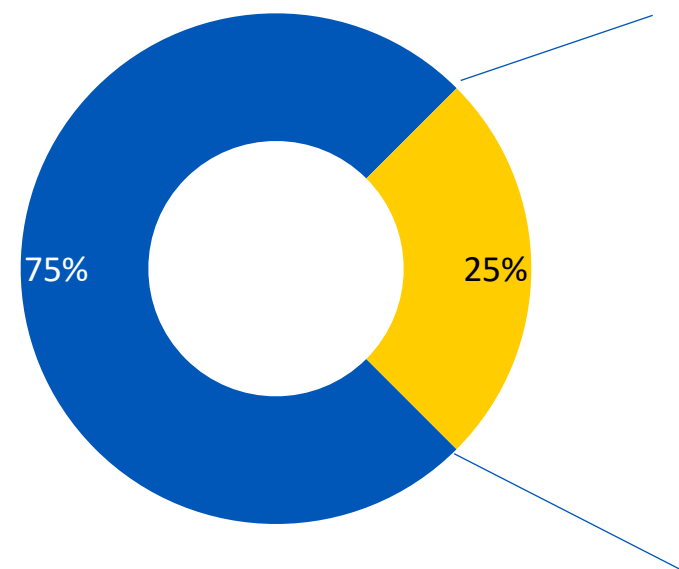
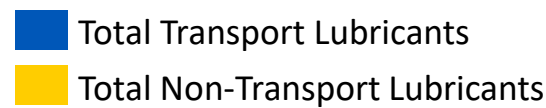
# About Braskem



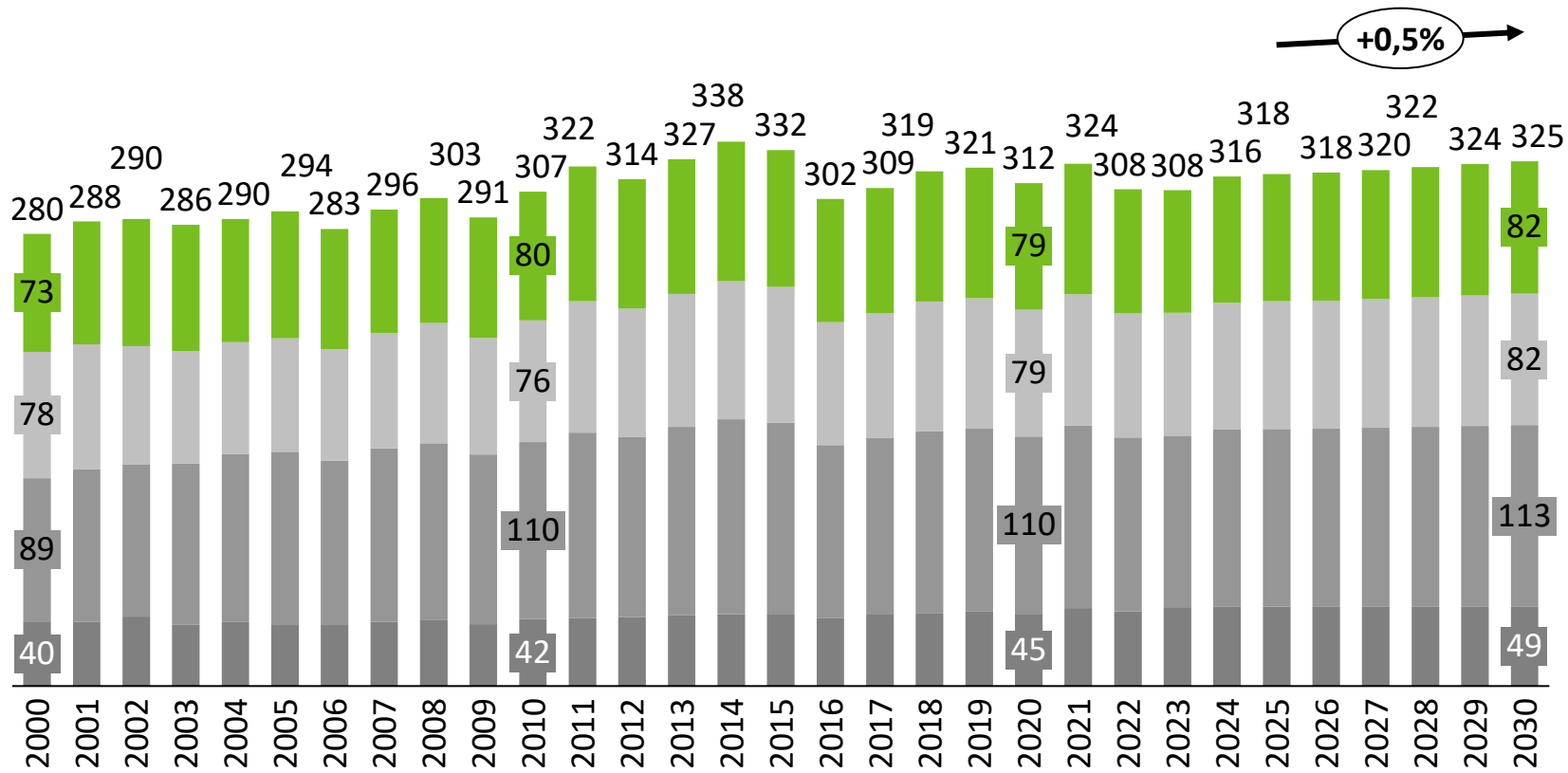
# Sugarcane Industry

## Segment Review

### 2025 Lubricants Demand (kt) - Brazil



### Non-Transport Lubricants Demand (kt) - Brazil

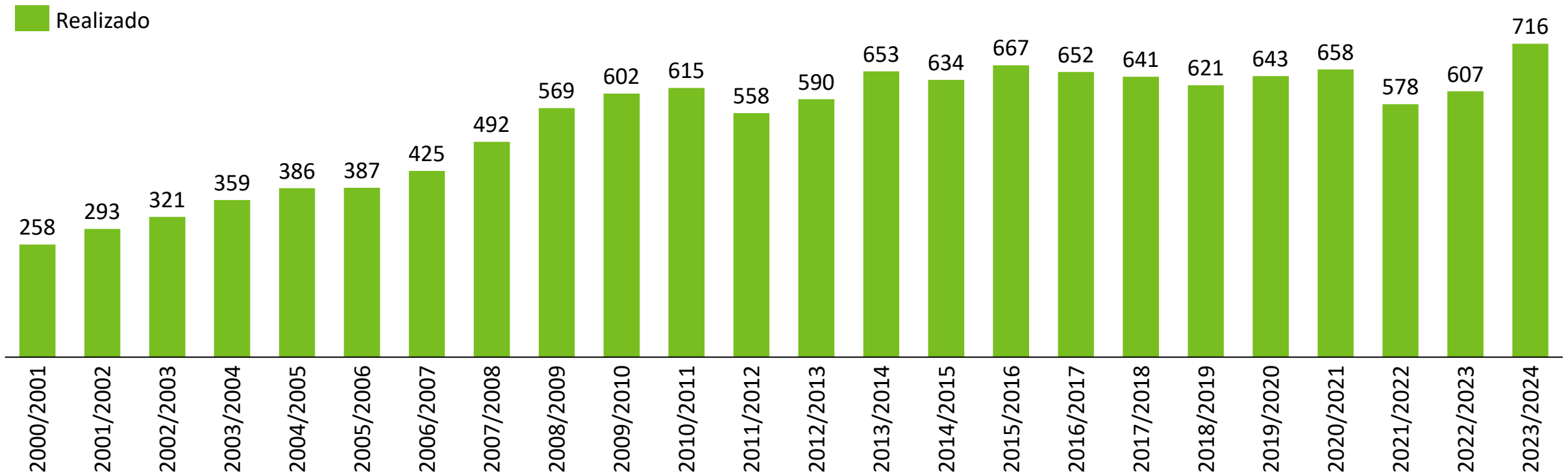


Source: S&P Global's Lubricants Demand Model

# Sugarcane Industry

## Segment Review

### Histórico da moagem (million tons) - Brazil

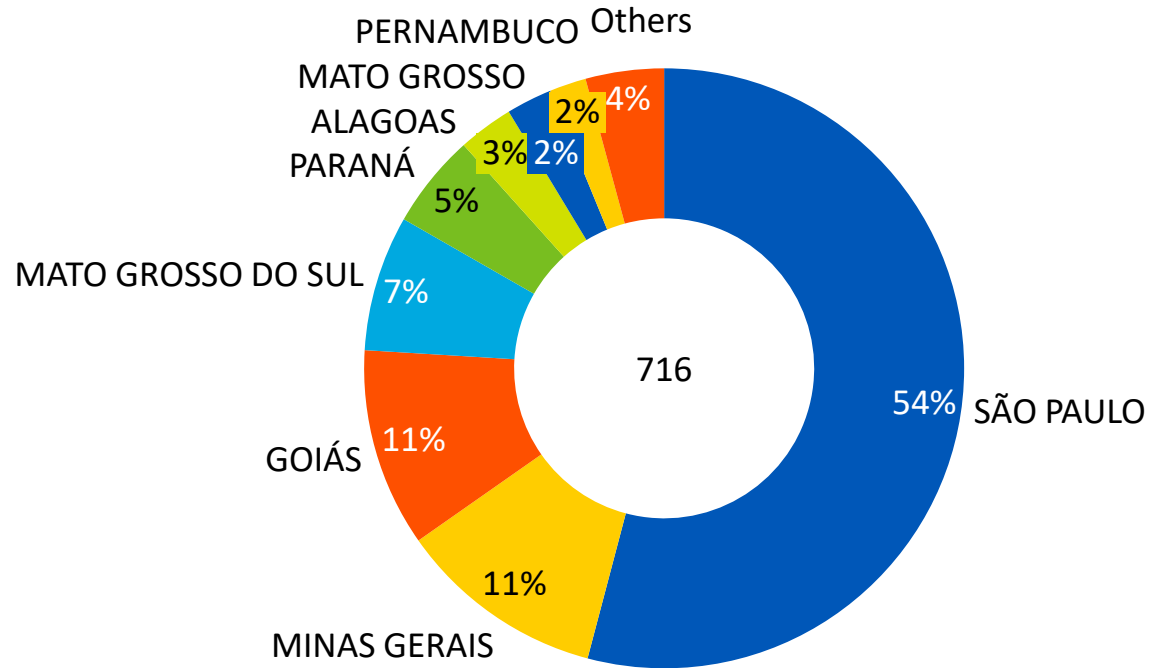


**Source:** S&P Global's World Ethanol Production by Country; ÚNICA: Histórico de acompanhamento da safra de cana-de-açúcar no centro-sul

# Sugarcane Industry

## Segment Review

Sugarcane Millingpor by state (million tons) - Brazil



Source: Única e S&P Global

**345** *ethanol plants in operation*

**21** *under construction*

**28** *projects under evaluation*

World ethanol production to break records in 2026 and 2027. The most substantial rise in absolute terms will occur in South America and Asia



+11% | 23/24 to 2027

**(40 million cubic meters)**



# Sugarcane Industry

## Environmental Review

Sugarcane production occupies ~1% of total area. Production increase driven mainly by efficiency

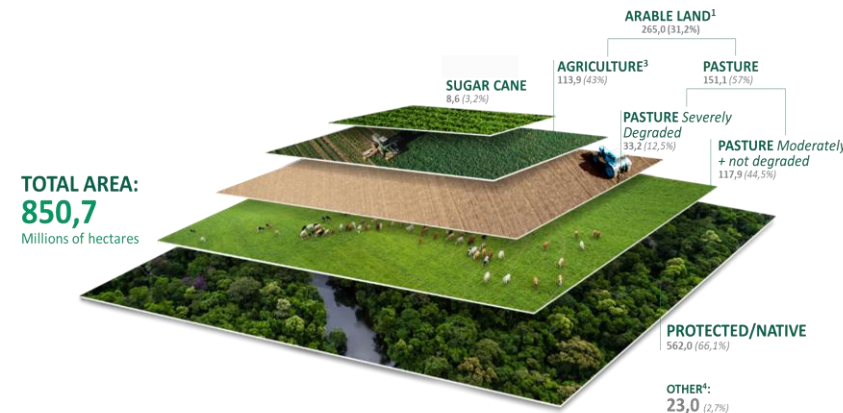


Production



Infrastructure

- 1<sup>st</sup> producer sugarcane, 2<sup>nd</sup> ethanol
- 32 billion liters of sugarcane ethanol - 2034 (+5 billion L vs 2024)<sup>1</sup>
- Second-generation ethanol technologies
- Capacity expansions: investments and improvements in ethanol mills (+3.8 billion L 2024-34)<sup>1</sup>
- Logistics: enhancements in transportation and logistics



**66% of Brazilian total land (562 MM ha) is protected or native** while **31% is arable**. From this, **114 MM ha** are used for agriculture (**13% of total land**)<sup>1</sup>



Sugarcane production uses **~9 MM ha**, which represents **~3% of Brazilian arable land** (or **~1% of total**)<sup>1</sup>



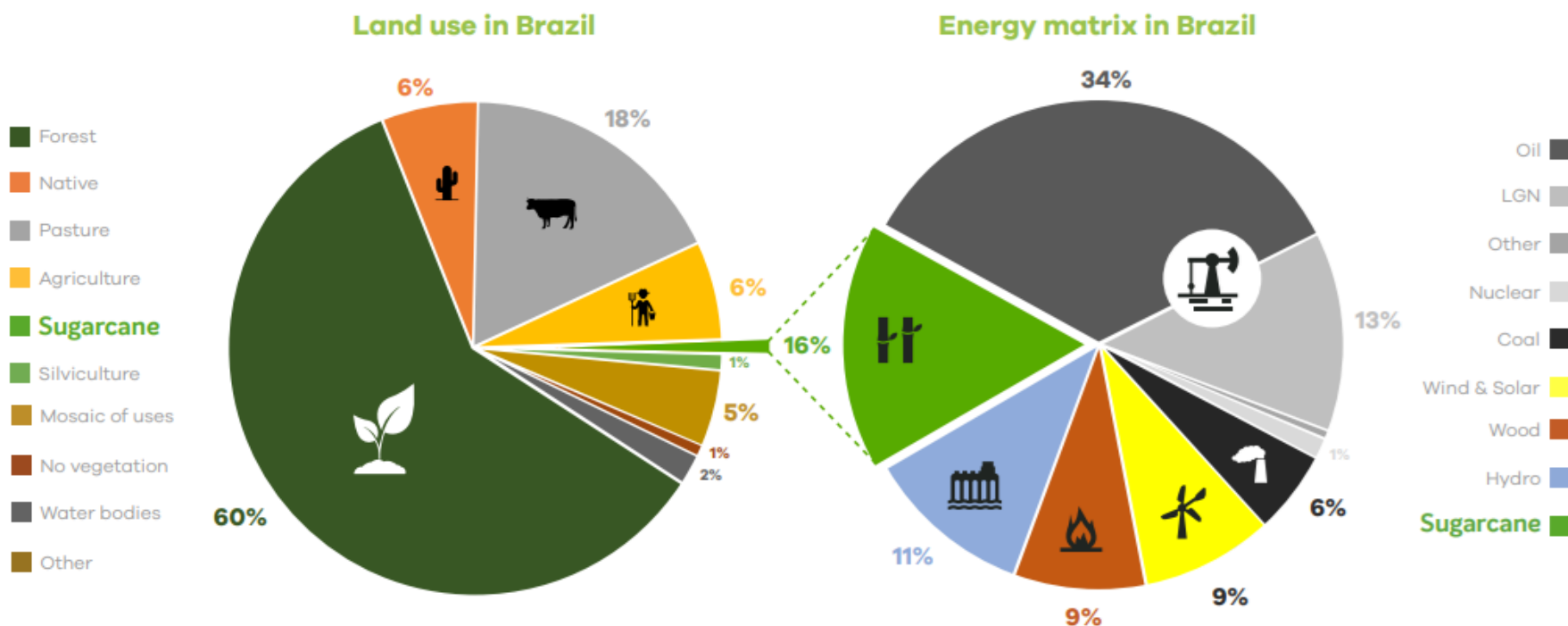
Production increase driven by efficiency<sup>1</sup>

	2013 - 2023	
Productivity	+13 t/ha	+21%
Planted Area	+0,2 Mha	+2%

# Sugarcane Industry

## Environmental Review

While occupying ~1% of the country's land, sugarcane supplies over 16% of Brazil's energy demand



**Sugarcane** is the **primary source of renewable energy** on a matrix of 314 million toe\*. It represents **~16%** of the national Brazilian matrix<sup>1</sup>

Renewable sources represent **~47%** of Brazilian energy matrix. Globally, they represent **~14%**<sup>1</sup>

\*toe: ton of oil equivalent

# Sugarcane Industry

## General, importance and challenges



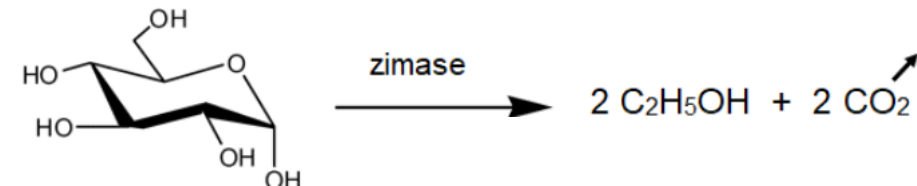
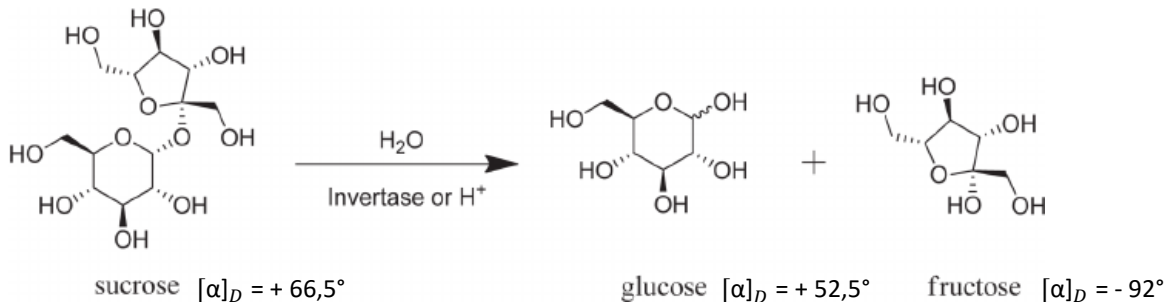
- The production is limited to a certain time of the year:
  - **South-Central:** April to November
  - **North/Northeast:** September to March
- Extreme Weather Conditions and its impacts in the “ATR” concentration

**Non-stop operation:** efficient lubrication



### Main Steps:

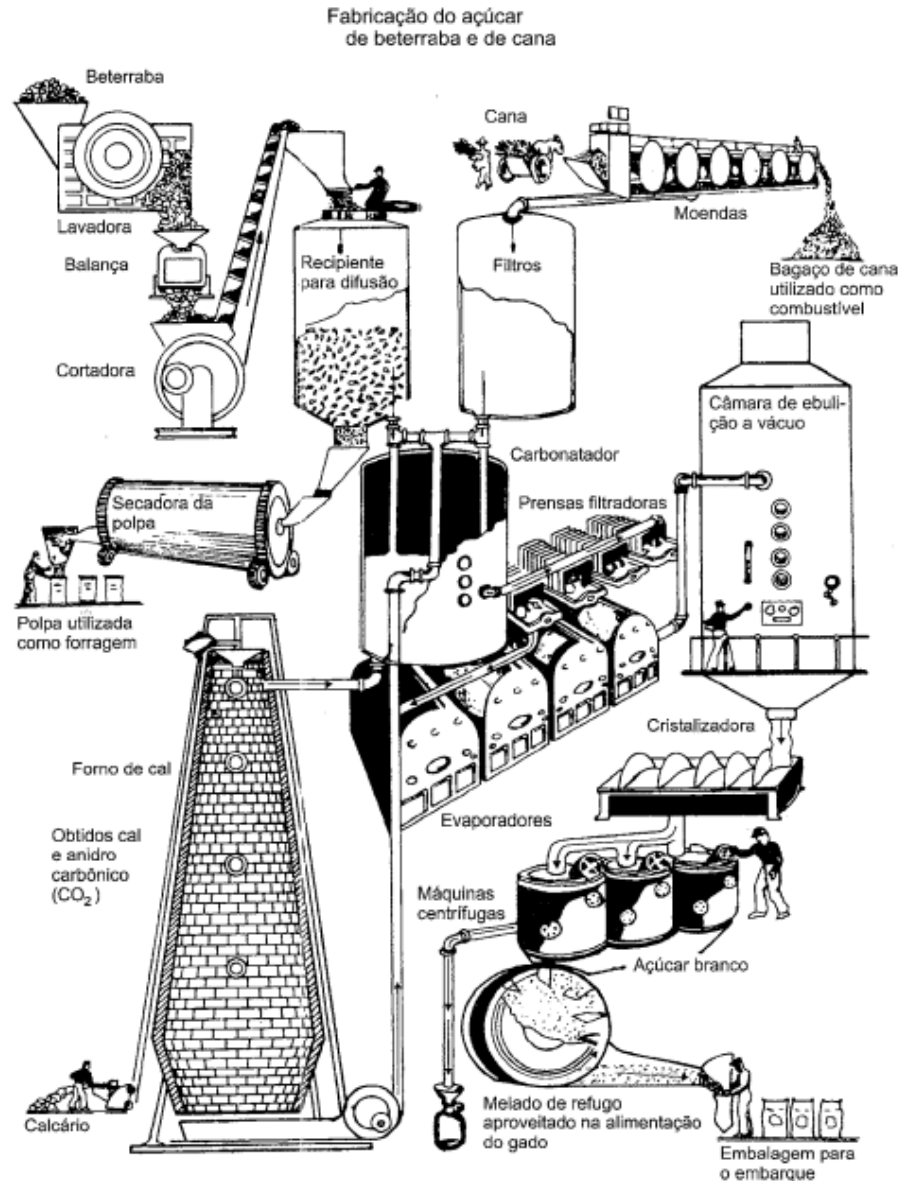
1. Harvest;
  2. Milling;
  3. Juice clarification;
  4. Juice concentration;
  5. Juice x sugar separation;
- 5.1** Chemical treatment of sugar;
- 5.2** Ethanol production.





# Sugarcane Industry

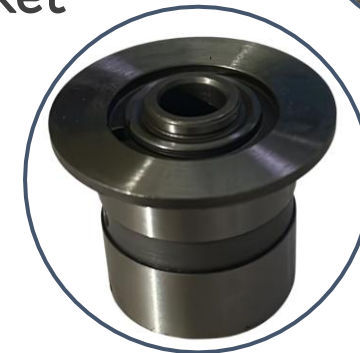
## Milling Machinery



Sprocket



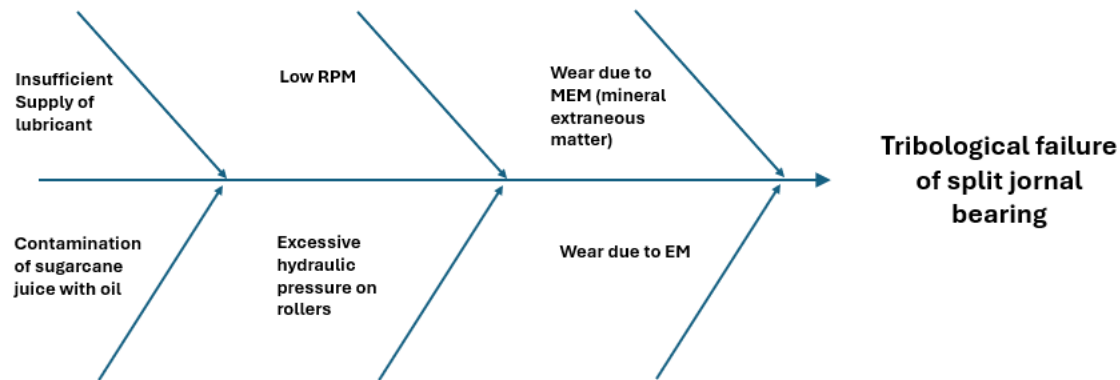
Milling  
"Volandeira"



Bearing

# Sugarcane Industry

## Lubrication Requirements



Tribological Failure Analysis and Suitability of Grease Lubrication for Sugarcane Crushing Mill Journal Bearings - P. N. Nagare, - H. N. Kudal; J Fail. Anal. and Preven. 2018

### Critical phase:

- **Juice extraction** via pressing or milling
- Sugar mill throughput depends on **crushing unit performance**
- Crushing unit uses **rollers mounted on journal bearings**
- Bearings operate at **low speeds (3–50 rpm)** under **high static and dynamic loads**

### Harsh Operating Conditions

- Bearings exposed to:
  - Corrosive cane juice
  - Moisture
  - Particulate contaminants

### In sugarcane crushing:

- Bearings operate under boundary or mixed lubrication
- Due to slow speeds and high mechanical stress



**Robust lubrication strategies** to minimize wear and ensure reliability

# Sugarcane Industry

## Lubrication Requirements



### Mills

- Rollers operate at **low speeds (3–5 rpm)**
- Journal bearing surfaces endure pressures of **100–150 kg/cm<sup>2</sup>**

*Lubricant must offer:*

- Proper **viscosity**
- Strong **adhesion to metal surfaces**
- Excellent **film strength**
- Adequate **protection against wear** on bearings
- Effective **rust and corrosion protection**



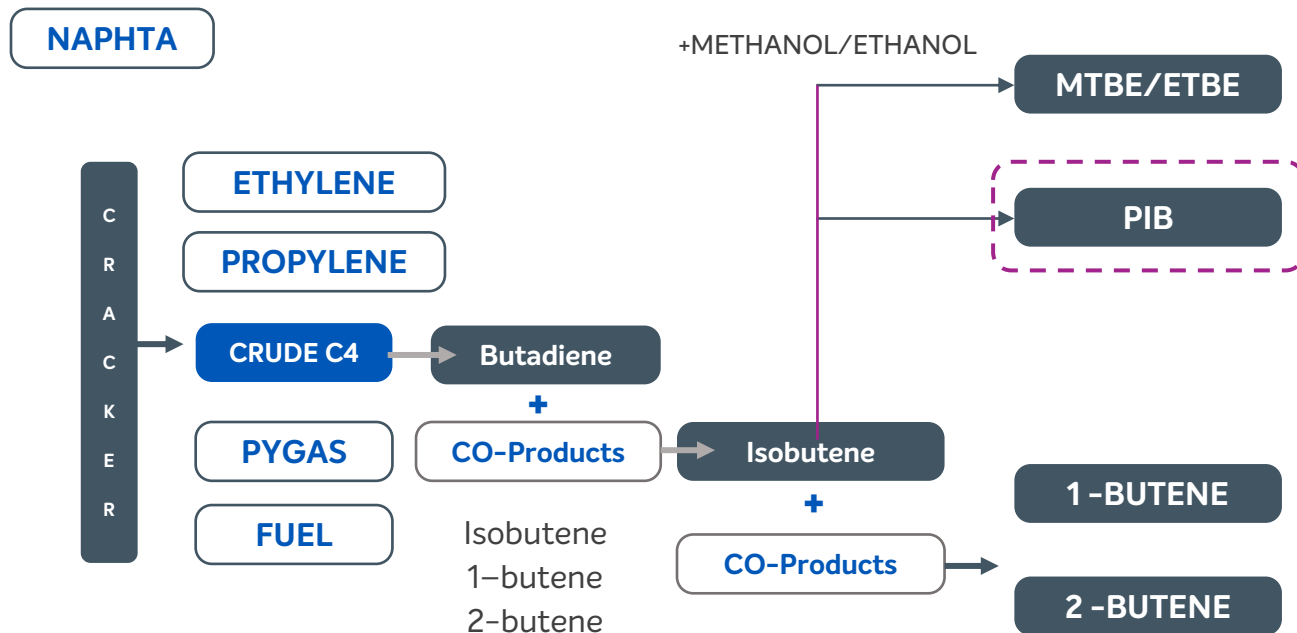
### Gears

- Gears are **open-type** and require lubricants with:
  - **High viscosity**
    - Excellent **adhesiveness**
- Due to the difficulty of cold application, these lubricants are:
  - Supplied in **fluid state** via mixing with **non-flammable solvents**, or
  - **Heated** to facilitate application
- Lubricants must also provide:
  - Strong **film resistance**
  - Ability to **resist oxidation** and **prevent deposit formation**

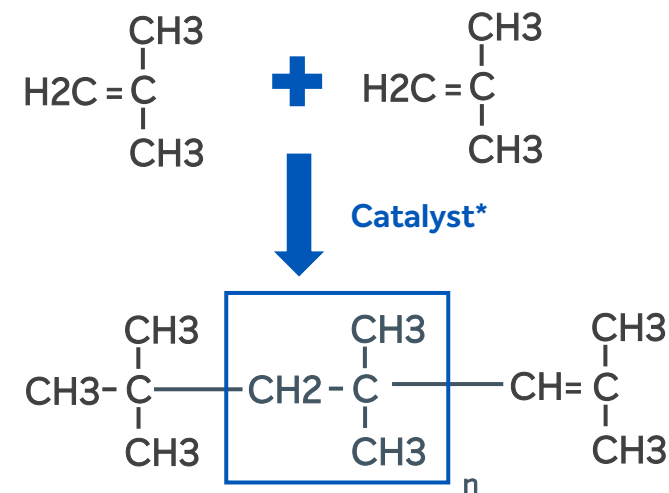
Polyisobutene (PIB)

# Braskem PIB

## Production Process



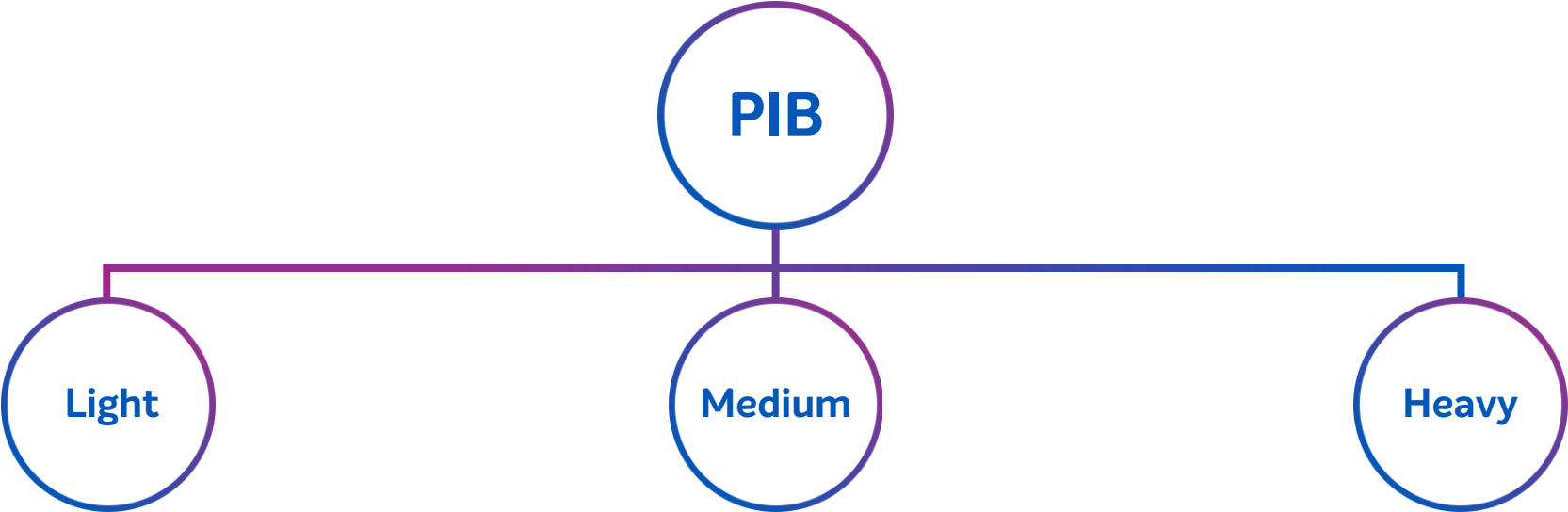
## Reaction



\*In the presence of an acid catalyst and heat

# Braskem PIB

Portfolio



PIB	Molecular Weight (g/mol)	Viscosity at 37.8°C (cSt)
4	350	16
6	365	30
8	500	106
10	600	500
16	675	1000

PIB	Molecular Weight (g/mol)	Viscosity at 37.8°C (cSt)
24	1080	8710
30	1300	19500
32	1345	28000

PIB	Molecular Weight (g/mol)	Viscosity at 100°C (cSt)
90	1948	2000
120	2100	2500
122	2425	3200
128	2500	4350
240	4200	12500



# Braskem PIB

## Typical Values

Properties	Average Molecular Weight	Polydispersity Index (Mw/Mn)	Density at 20/4°C	Viscosity (37,8°C)	Viscosity (100°C)	Color (Pt-Co)	Water	Flash Point	Chlorine
Unit	Daltons		g/cm <sup>3</sup>	cSt	cSt	-	ppm	°C	ppm
Test Method	Internal GPC method	Internal GPC method	ASTM D 4052	ASTM D 445	ASTM D 445	ASTM D 1209	ASTM E 203	ASTM D 92	ASTM D 5808
GRADES									
PIB4	350	1.14	0.82	16		70	80	125	180
PIB6	365	1.66	0.84	30	6	70	80	125	180
PIB8	500	2.16	0.85	106	12	70	80	130	180
PIB10	600	2.02	0.87	500	25	60	70	130	180
PIB16	675	3.00	0.88	1000	49	60	60	135	180
PIB24	1080	2.4	0.89	8710	220	50	50	190	160
PIB30	1300	1.8	0.90	19500	630	50	40	190	160
PIB32	1345	2.94	0.90	28000	680	50	50	195	160
PIB90	1948	3.5	0.91		2000	10	20	200	
PIB120	2100	2.2	0.91		2500	50	50	220	170
PIB122	2425	3.4	0.91		3200	50	50	235	170
PIB128	2500	3.9	0.91		4350	50	50	240	170
PIB240	4200	3.59	0.92		12500	50	50	245	170



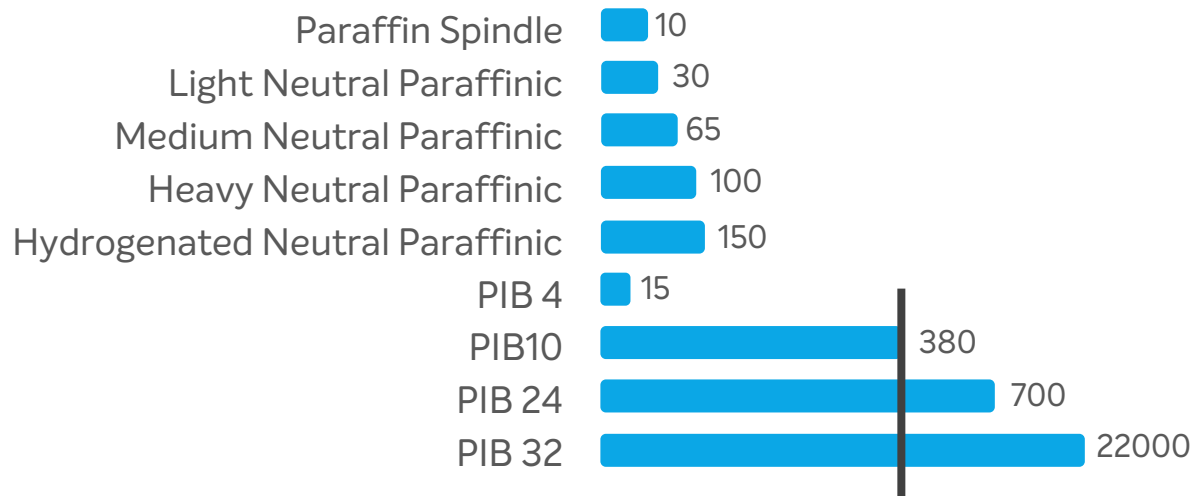
# Braskem PIB

## Physical and chemical general properties

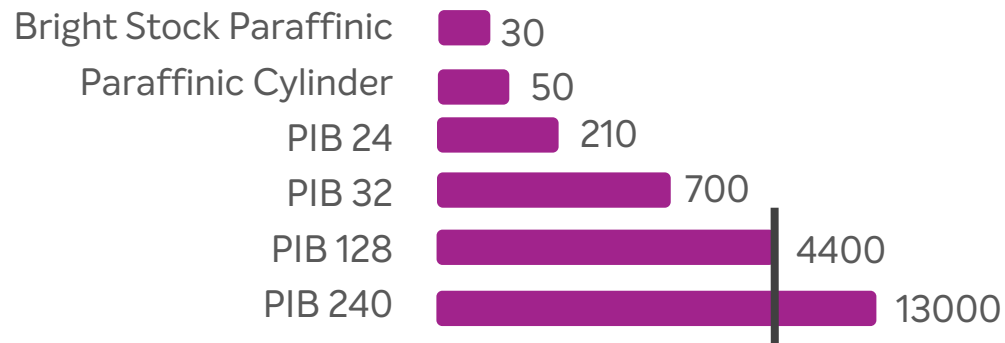
- ***Physical State:*** liquid
- ***Color:*** colorless
- ***Odor:*** odorless
- ***Solubility:*** nonpolar solvents
- ***Solubility in water:*** no
- ***Burn:*** clean burn



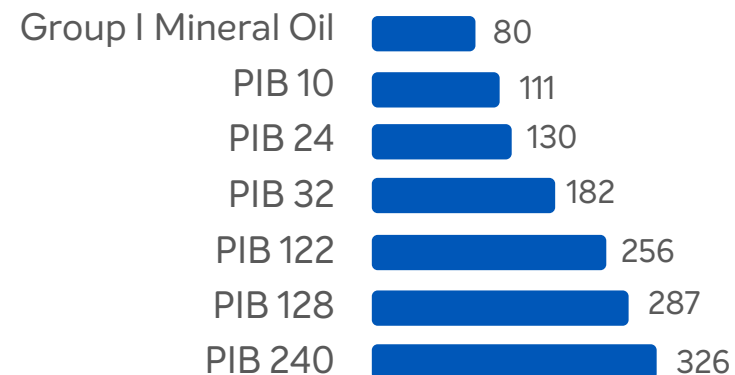
### Viscosity 40°C (cSt)



### Viscosity 100°C (cSt)



### Viscosity Index



Viscosity Index



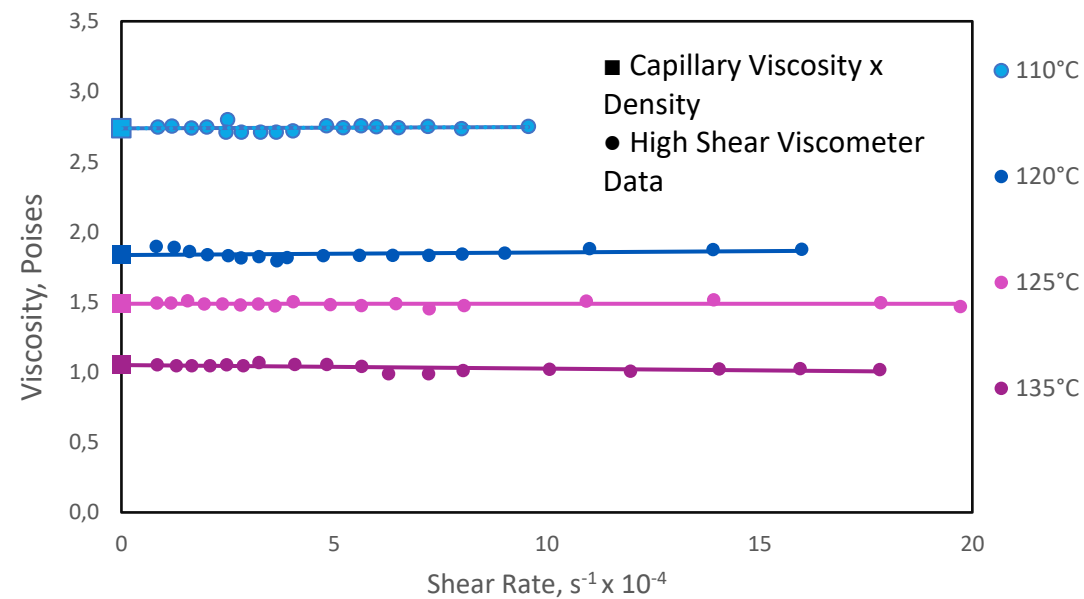
Variation of viscosity with variation of temperature

### Four Ball Wear Test

Test Operating at 600 RPM / 60°C and 60 Kg force

SCAR DIAMETER (mm)			RATING SCALE
	1 hour	8 hour	
Oil Blend 50% SAE - 50 and 50% Zero bright stock visc. 37.8°C - 120 cSt	0.68	1.20	0.7 mm - excelent 0.7 - 0.8 mm - good 0.8 - 1.0 mm - fair / poor
PIB 8	0.57	0.78	
PIB 24	0.60	-	
PIB 128	0.68	-	

### PIB32 | Shear Stability



# PIB in Industrial Machine Lubricant



## Requirements for lubricants used in milling machinery

- High Viscosity ✓
- Water Repellency ✓
- Requirement for incidental food contact ✓
- Anti-Corrosive Properties ✓
- High Temperature Resistance ✓
- Extreme Pressure Additives Compatibility ✓
- High tack to metal ✓



The **PIB** can be used as a **base oil** in this type of lubricant formulation, bringing benefits such as: low interaction with water, high viscosity, regulatory release for incidental contact with food, high tack and thermal stability at certain temperatures ranges.

### SUGGESTED FORMULATION

#### Base Oil

PIB: 30 – 95%

Mineral Oil: 5 – 70%

#### Additives

Extreme Pressure: 2.5 – 4%

Antioxidant: 1 – 2%

Anticorrosive: 1 – 2%

Medium and heavy PIB are suggested for this application



# Braskem PIB

## Product Regulatory Information

### POLYISOBUTENE- CAS # 9003-27-4

**NSF - H1** certified for incidental food contact lubricants

**EU** - Plastic materials and food contact substances

**EU** - Cosmetics

**U.S. - FDA** - Adhesives and coating components

**US FDA** - Paper and paperboard components

**U.S. - FDA** - Polymers

**US - FDA** - Adjuvants, processing aids and sanitizers

**MERCOSUR - GMC** - Materials for food contact



Nonfood Compounds  
(Category Code H1)



#### Regulatory Information Sheet (RIS)

Page 1/16

Product: PIB 6

#### SECTION I - FOOD CONTACT COMPLIANCE

Reviewed on 26 January, 2024

For regulatory information with regards to Food or Food Contact regulations, please, contact your local technical service.

#### SECTION II - GLOBAL REGULATORY INFORMATION

Reviewed on 26 January, 2024

# DO YOU WANT TO KNOW MORE?

*TS&D*



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THANK YOU!

