



Improving Oil Loss Data Quality at REFAP Refinery with SIGMAFINE

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Agenda

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- Presentation objectives
- Introduction
- Oil loss study
- Before Sigmafine implementation
- After Sigmafine implementation
- Summary

PETROBRAS



- 13th petroleum company in the world
- Headquarters in Rio de Janeiro - Brazil
- US\$ 22.612 billion yearly income
- US\$ 4.911 billion yearly investments
- 39,500 employees
- 132,000 shareholders
- 1,570,000 bpd oil production
- 1,710,000 bpd refining capacity
- 11 Refineries, 2 fertilizer plants



PETROBRAS

- 4 Refineries abroad
- Unparalleled offshore technology
(Twice honored with the deep-water oil production prize by OTC)
- Largest number of ISO-9000/14000 certificates in Brazil
- Shareholder of the 4 major petrochemical plants in Brazil

REFAP

(a PETROBRAS/REPSOL Refinery)



- Canoas-RS
- 20,000 m³/day
- 2 CDU; VDU; FCC;
Solvents; Bender
treatment of kerosene;
DEA naphtha /LPG
treatment for S removal;
Merox treatment of
cracked naphtha; Merox
treatment of LPG;
Sulphur recovery;
- +100 Tanks



Objectives

- Compare discrepancies of the monthly mass balance of hydrocarbons at REFAP Refinery, before and after implementation of Sigmafine
- Match results to best world practices

Introduction

- Reliability of mass balance was constantly questioned
- Corporate data base system produced an unreliable mass balance because data were not reconciled
- By the end of year 2000 SOTEICA won the bid to provide PETROBRAS a corporate-wide Data Reconciliation and Yield Accounting System
- Work began at REFAP and REPLAN Refineries in Feb 2001

Oil loss study

- Just after SIGMAFINE implementation at REFAP (October 2001), a Profit Improvement Program - PIP (by a contracted consultant) started
- PIP consultant made available almost one year of historical data as a reference base case

Oil loss study

- Source: Corporate Relational Database
- Loss accounting methodology by the IP: “Institute of Petroleum”

Oil loss study

- Oil Loss Study by Consultant recognized that: REFAP real losses are small but not well evaluated (data from Feb/2001 to Jan/2002)

Mass Balance before Sigmafine

Standard IP Report

Refinery Balance Feb-01 to Jan-02

Input (tonnes)			Outputs and Fuels (tonnes)		
Crude receipts	5,396,930		Measured shipments	7,250,888	
Others feedstocks	2,020,354		Petroleum Coke	0	
Gas Imports	39,591		Gas exports	0	
Water to Emulsions	0		Sub-total, outputs		7,250,888
Slop Imports	0		H ₂ in SRU feed to water	197	
Additives	255		Ammonia produced	0	
Sub-total, Receipts		7,457,129	Sub-total, others		197
			FCC coke	58,362	
			Fuel gas	99,419	
			FCC N ₂ Adjustment	-14,159	
			Fuel oil	77,617	
			Sub-total, fuel		221,240
Feedstock inventory			Product inventory		
Opening stock	189,350		Opening stock	186,471	
Closing stock	116,720		Closing stock	161,681	
Inventory change		72,630	Inventory change		-24,789
			Total outputs + fuel		7,447,535
			Loss	1.09%	82,224
Total processed inputs		7,529,759	Total		7,529,759

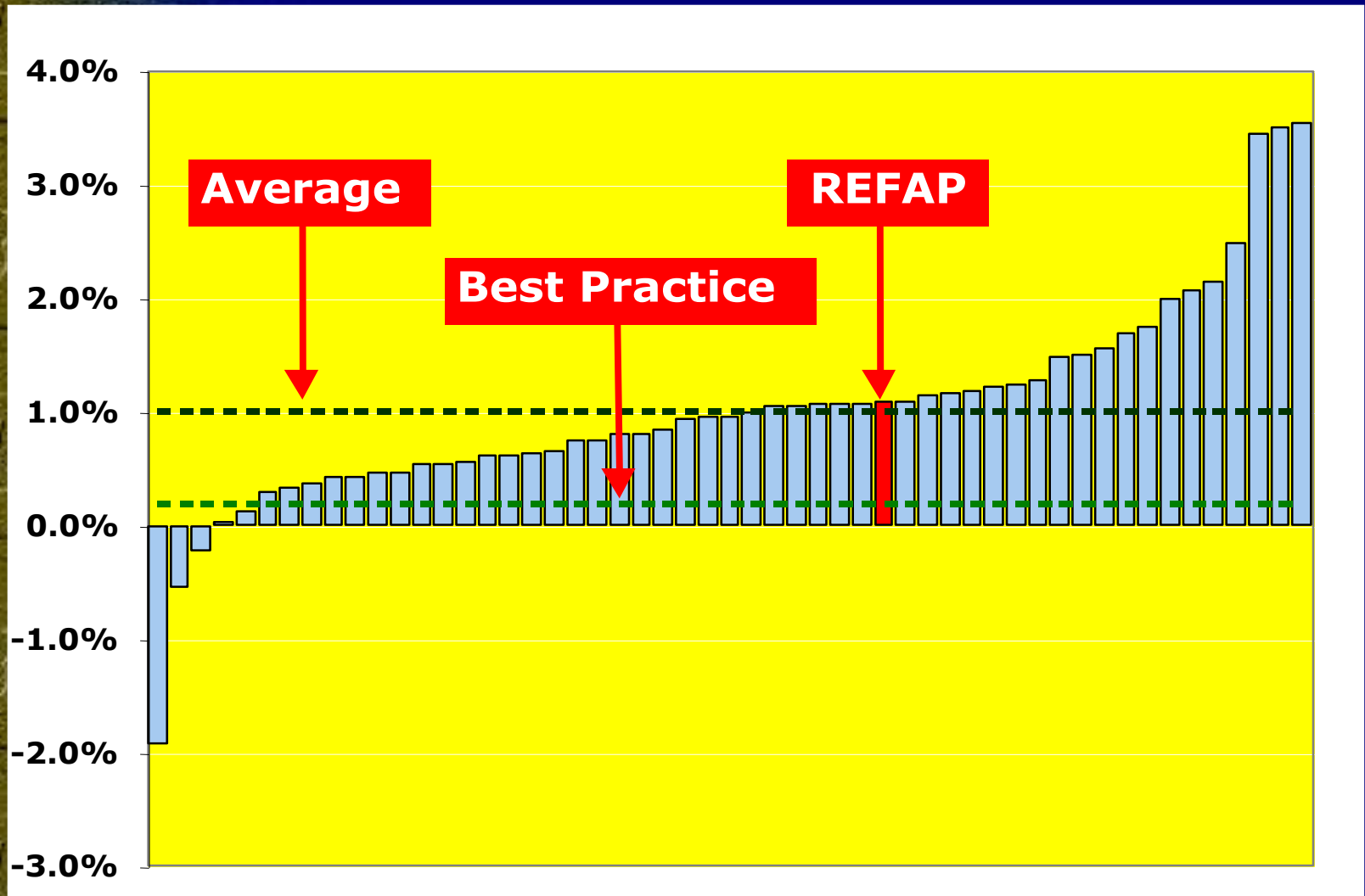
Mass Balance before Sigmafine Accounted Loss

Accounted Loss, Feb-01 to Jan-02

	tonnes	%	On Input
Crude Measurement	0	0.0%	0.00%
API drainage evaporation	2,144	2.6%	0.03%
Flares	226	0.3%	0.00%
Tank Evaporation	197	0.2%	0.00%
Flare pilots & purge	0	0.0%	0.00%
Crude Water Method	10,794	13.1%	0.14%
Inert Gas Blanket	0	0.0%	0.00%
Refinery Liquid Effluent	0	0.0%	0.00%
Process fugitives	0	0.0%	0.00%
Cooling towers	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
	0	0.0%	0.00%
Accounted Loss	13,361	16%	0.18%
Unaccounted Loss	68,864	84%	0.91%
Total Loss	82,224		1.09%

Mass Balance before Sigmafine

Best practices (0.2%)

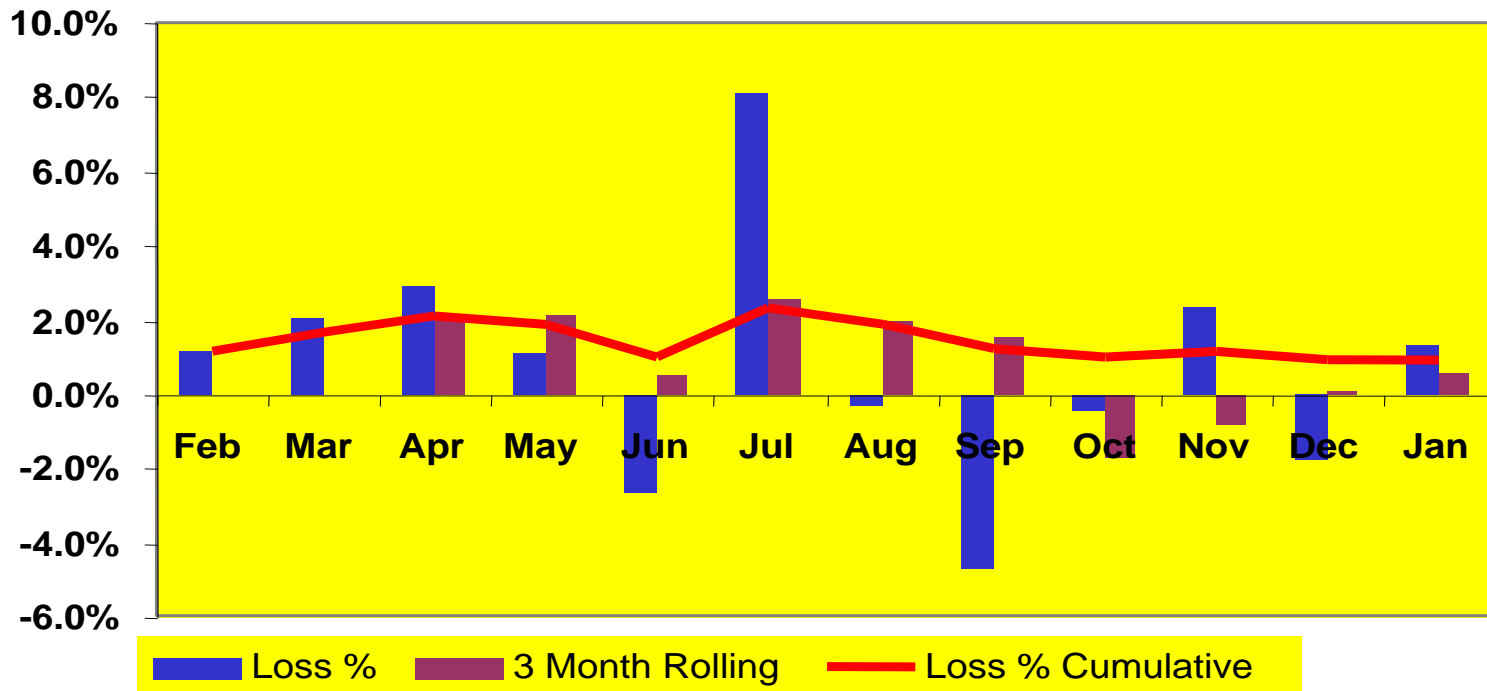


Mass Balance before Sigmafine

Consultant Loss Study

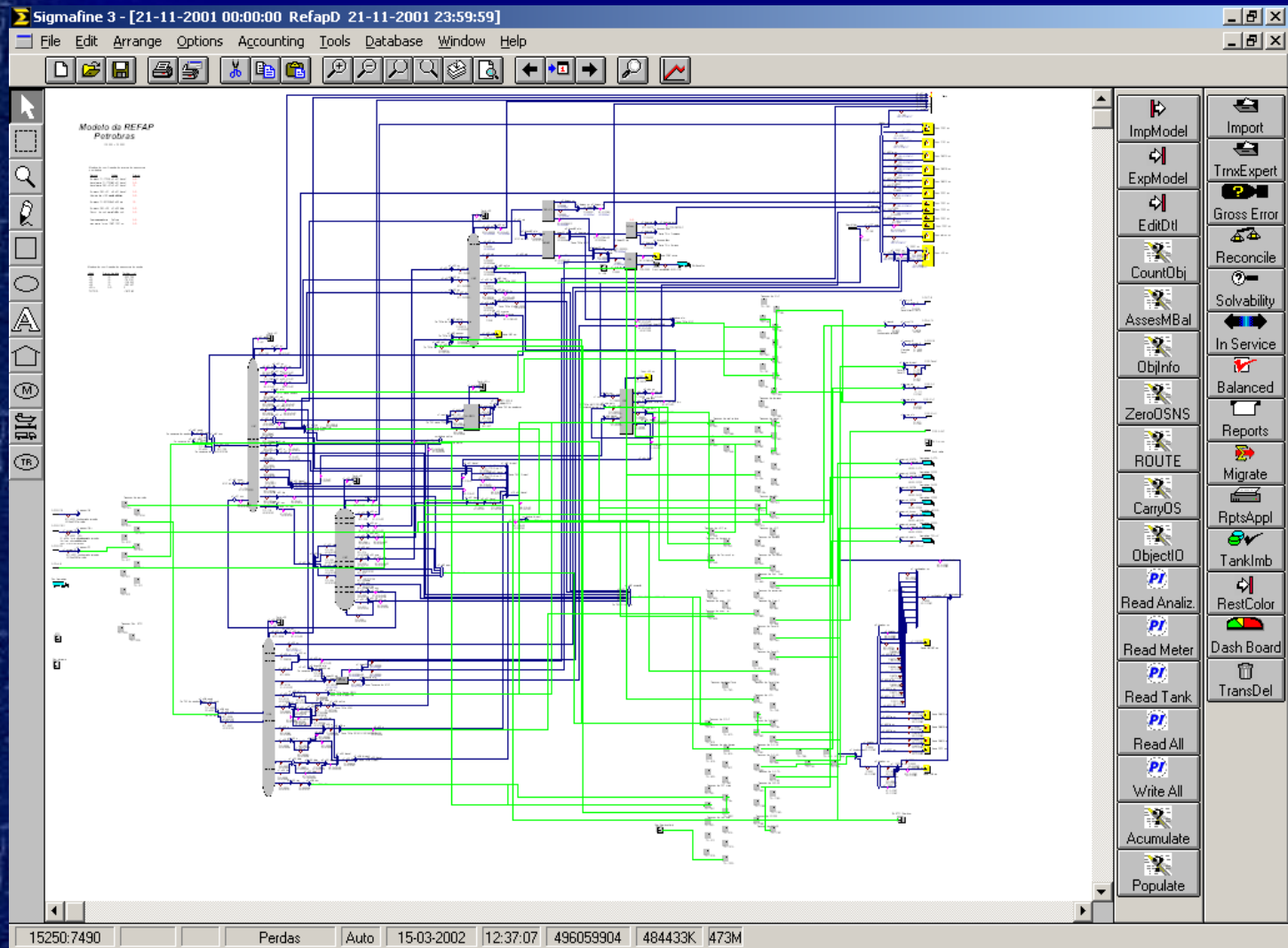
Feb/01 - Jan/02

(Loss % Cumulative = 1.09%)



Mass Balance after Sigmafine

Jun/02-Nov/02



Mass Balance after Sigmafine (Jun/02-Nov/02)

Tools Used:

- Yield Accounting and Data Reconciliation accomplished by SIGMAFINE
- Process and lab measurements from PI
- Transactions and tanks – from Corporate Relational Database system

Mass Balance after Sigmafine

Present Procedure

- Corporate Database:
 - Executes daily balances, tank by tank, considering opening and closing stocks, processing, shipments, and receipts (transactions)
 - Some are done in volume base, others in mass base
 - Do not take into account process data (handled by PI)
- SIGMAFINE:
 - Executes daily balances, tank by tank, considering opening and closing stocks, processing, shipments, and receipts (transactions), in mass base only
 - Takes into account process data (PI)
 - Corrects the corporate relational database transactions (by the time being, manually), which become REFAP Refinery official data
 - Overall, SF allows the corporate system to overcome its deficiencies

Oil Loss figures after SIGMAFINE implementation

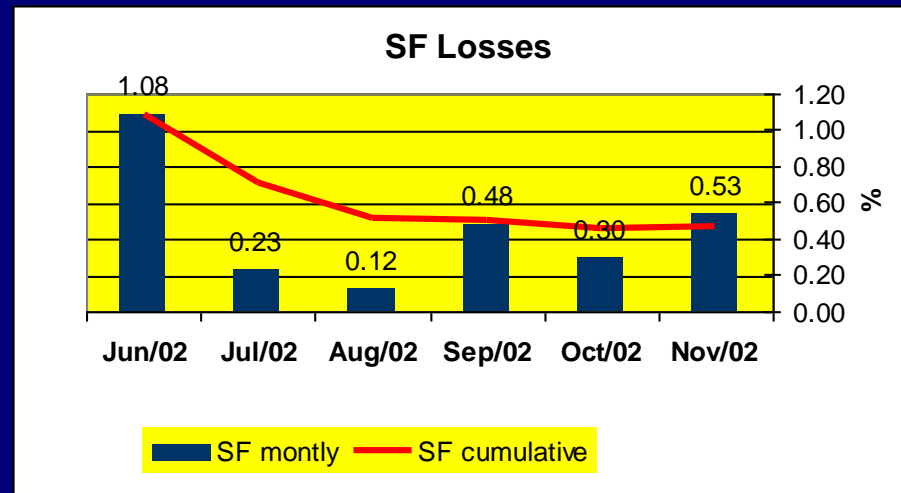
Accounted losses - Estimates

	Crude	Evaporation			Losses (ton)		Losses (%)	
	Measurement	API	Tanks	Flare	Accounted	Total	Accounted	Total
Jun/02	929	68	16	180	1193	7 745	0.17	1.08
Jul/02	582	120	16	5	723	1 294	0.13	0.23
Aug/02	920	35	16	5	976	796	0.15	0.12
Sep/02	912	120	16	6	1053	3 350	0.15	0.48
Oct/02	1 007	100	16	260	1383	2 226	0.18	0.30
Nov/02	793	60	16	35	904	3 487	0.14	0.53
Total	5 143	503	96	491	6 233	18 899	0.15	0.47

Oil loss figures after Sigmafine implementation

REFAP Mass Balance Follow up

	Sigma Fine					
	Monthly			Loss % Cumulative		
	Inputs	Losses	%	Inputs	Losses	%
Jun/02	715 848	7 745	1.08	715848	7745	1.08
Jul/02	565 009	1 294	0.23	1280857	9040	0.71
Aug/02	639 548	796	0.12	1920406	9836	0.51
Sep/02	698 228	3 350	0.48	2618634	13186	0.50
Oct/02	749 267	2 226	0.30	3367902	15411	0.46
Nov/02	654 793	3 487	0.53	4022694	18899	0.47



Oil loss after SIGMAFINE implementation

- Loss % cumulative (Jul/02 - Nov/02)
 - Loss after SIGMAFINE = 0.34%
 - Benchmark Best Practice = 0.2 %

Note: excluding Jun/02 - to eliminate possible stock error in the beginning of the procedure

Main accounting problems in Corporate database (PETROBRAS official data) corrected by the application of SIGMAFINE

- **SIGMAFINE forced a change of procedures**
 - **Coke production in the FCC Unit was not considered. Now it is.**
 - **Free water in crude arriving to the refinery was not excluded of the receipt transactions. As a consequence, the transactions showed a receipt amount of raw material larger than the true value. For the purpose of crude payment, water was excluded by a lab analysis, but for the sake of mass balance, water ended up as oil loss. Now the drained water is excluded of the input amount of crude.**

Other benefits

- **SIGMAFINE:**

- Made easier the identification of mistakes in the opening of transactions.
- Made easier the correction of densities of stocks and transactions, increasing the precision of conversion from volume to mass.

- After SIGMAFINE implementation, corporate database gets reconciled data from SIGMAFINE.

Difficulties in using SF data

- Person in charge must be well trained
- Takes analysis time to find out the mistakes
- Relies on several systems (PI, Relational database, DCS, Transactions system, etc.) functioning well.
- Relies on several operator manual decisions and lab results (buttons on DCS, inputs of beginning and end of transactions) some of which must be taken in the exact time of the event.
- Monthly mass balance must be ready by the next day after the end of the month and can not be changed afterwards

Summary

- The use of SF together with the Company relational database increased the quality of REFAP stock, shipment and receipts official data. **SIGMAFINE gave “mass” quality to it.**
- Improvement of data quality, caused REFAP evaluation of losses to reach benchmark standards in the refining industry.

What next...

- Substitution of the methodology of analysis of water and sediments in the crude (BSW → Water by Karl Fisher + Sediments by extraction), might bring an improvement of about 0.12 % in the mass balance.
(This was proven to be untrue by comparison of lab analysis.)
- Send automatically the full set of reconciled data from SF to the relational database. Considerable improvement in the quality of data is going to be achieved.



Thank you!