Examples of Bioreactor Operating Experience

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Tucuman Bioreactor

- Part of a multi-year project being undertaken in Tucuman, Argentina
- Cell One - 30 m x 50 m x 6 m depth
- Estimated 6200 tonnes of refuse

2

Tucuman Bioreactor

- Expected rate of gas generation k= 0.024/yr
- Value obtained to date k' = 0.515/yr

- 75 cfm at 45% methane

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Situation prior to construction of Bioreactor

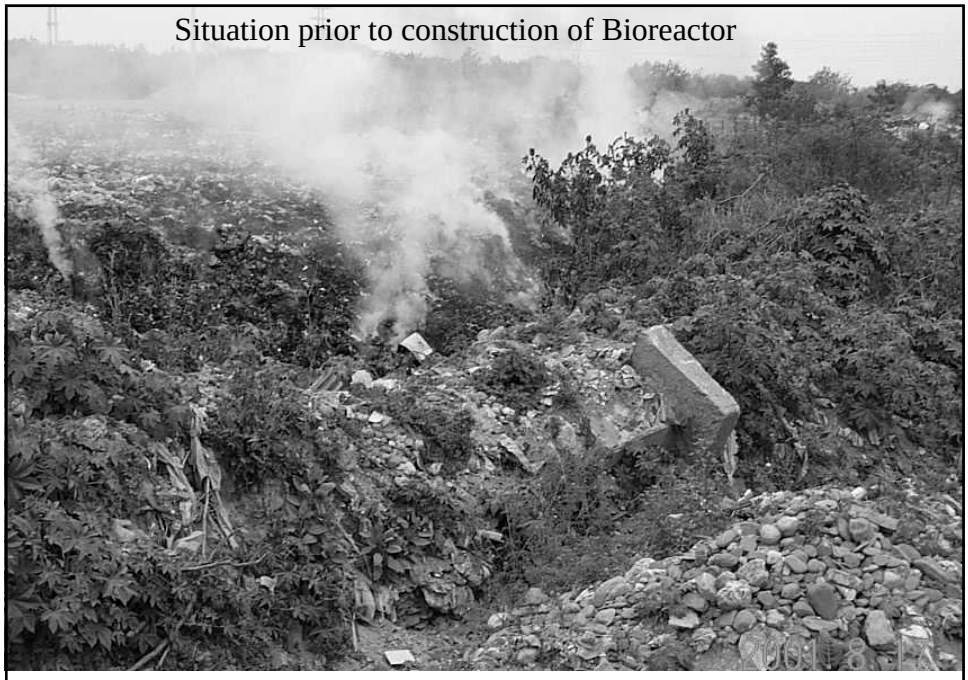

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Table 2: Comparison of Waste Compositions (in%) in Argentina and Canad

Constituent Category	*Tucumán, Argentina*	*Vancouver, Canad*
Organics	64.1	33.5
Plastics	7.05	13.3
Metals	2	3.4
Batteries	0.1	0.1
Bottles/Glass	3.1	3.1
Textiles	1.3	3.9
Diapers	6.1	2.5
Paper, Newsprint	9.0	27.1
Cardboard	3.2	5.2
Styrene	0.1	Nm
Inorganics/Other	3.8	2.92

Table 1: Mean climatic data, Tucumán, Argentina

Months	Mean Air Temperature (°C)	Mean precipitation (mm)
January	24.5	183
February	23.7	159
March	22	162
April	18.3	59
May	15.4	29
June	12.3	19
July	12.6	10
August	14	8
September	17.1	12
October	20.2	77
November	22.5	108
December	24.6	150
Total	19	976

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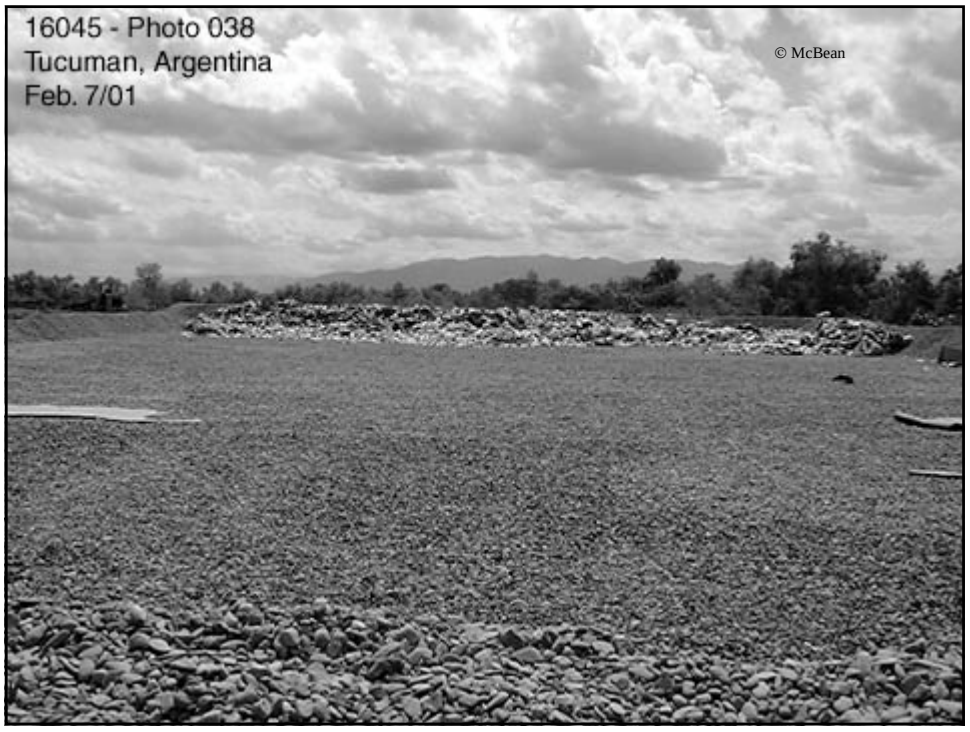


16045 - Photo 039
Tucuman, Argentina
Feb. 7/01
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16045 - Photo 041
Tucuman, Argentina Feb. 7/01
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Photo #017
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Tucuman, Argentina
August 1/01
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Photo 15

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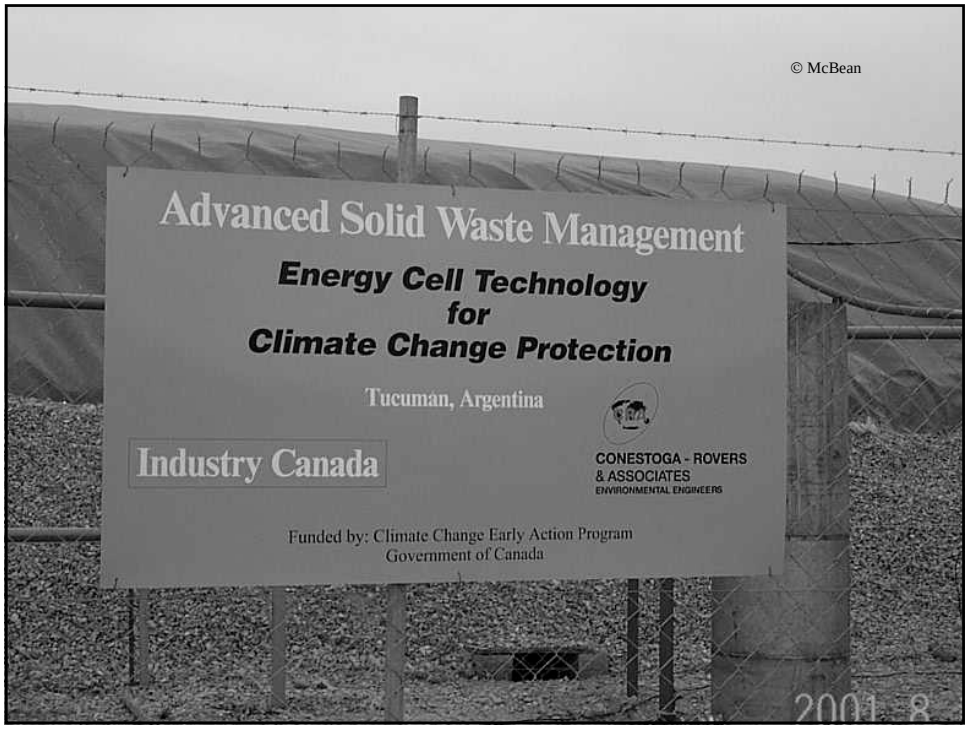

Table 3: Nonlinear Regression Results

Constituent Gas	Regression Result	K (year^{-1})	L_o (m^3/metric tonne)
LFG	$G = 0.49 \cdot L_0 \cdot M \cdot e^{(-0.49\ t)}$	0.49	322
Methane	$G = 0.51 \cdot L_0 \cdot M \cdot e^{(-0.51\ t)}$	0.51	167

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Table 4: Time to Varying Percentages of Cumulative Methane Generation

Time to:	*Tucumán Bioreactor Rate Constant* (1) *k = 0.515 year^{-1}*	*USEPA Rate Constant* (2) *k=0.21 year^{-1}*	*Ontario Rate Constant* (3) *k = 0.024 year^{-1}*
50% generation	1.3 years	3.2 years	28.8 years
80% generation	3.1 years	7.6 years	66.9 years
95% generation	5.8 years	14.2 years	124.5 years

Notes:

(1) Calculated Rate Constant for the Tucumán Bioreactor
(2) Maximum USEPA Rate Constant; k=0.21 year^{-1} (Pelt *et al.*, 1998)
(3) Default Rate Constant for the Province of Ontario; (k = 0.024 year^{-1}) (Levelton, 1991; Environment Canada, 2001)

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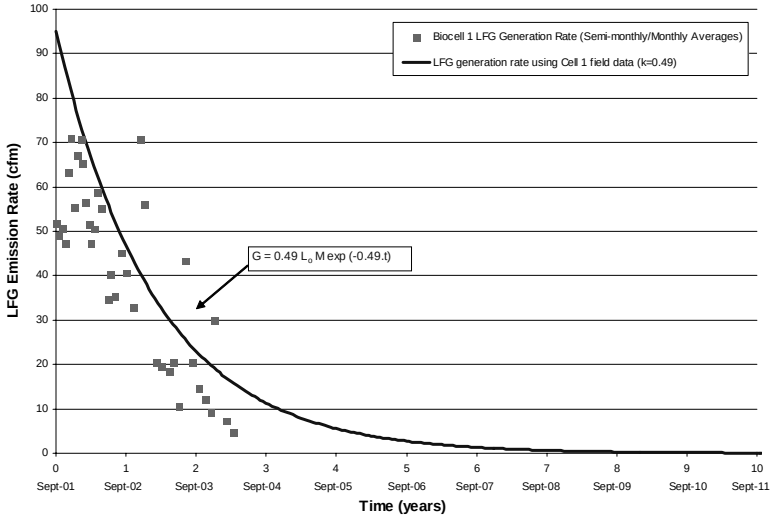

Figure 2A: LFG Generation Rate over Time, Tucumán Bioreactor, Argentina

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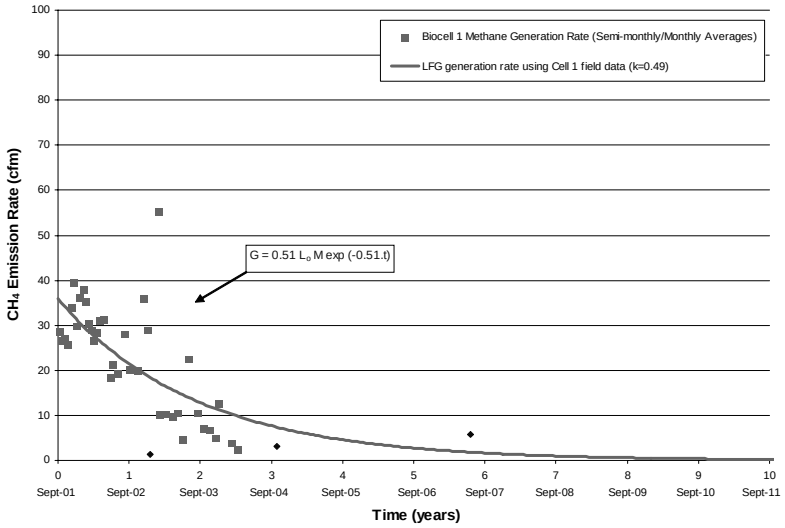

Figure 2B: Methane Generation Rate over Time, Tucumán Bioreactor, Argentina

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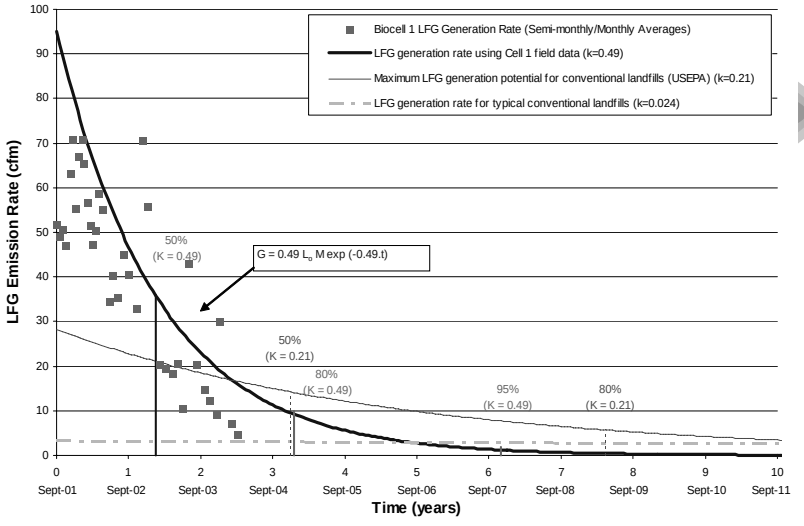

Figure 3A: Comparison of Different Rate Constants on LFG Data, Tucumán Bioreactor, Argentina

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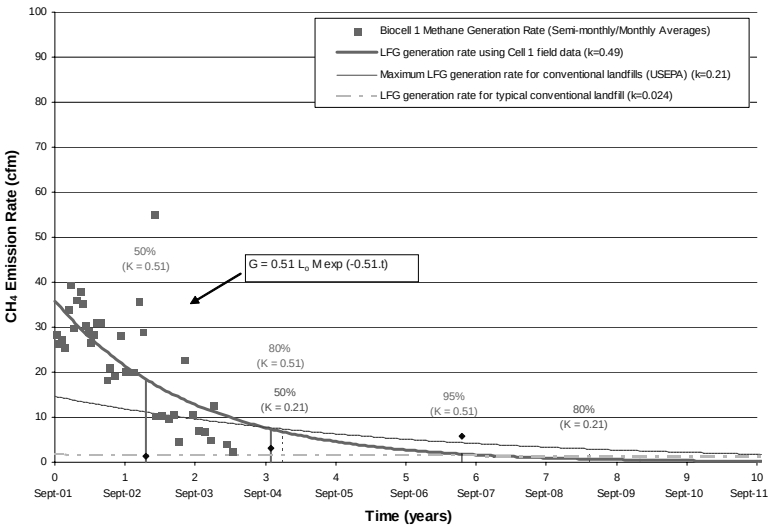

Figure 3B: Comparison of Different Rate Constants on Methane Data, Tucumán Bioreactor, Argentina

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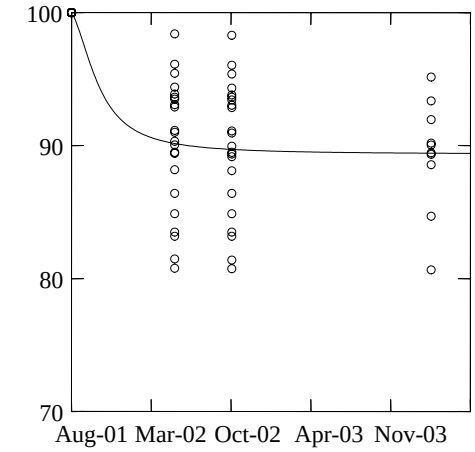

Figure 5: Subsidence Rate over Time, Tucumán Bioreactor, Argentina

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Table 5: Heavy Metal Concentrations in Leachate over Time

Metal (mg/L)	Time			
	March 2002 (7 months)	**December 2002 (17 months)**	**February 2003 19 months**	**December 2004 40 months**
Chromium	1.4	1.07	0.65	0.85
Lead	0.23	Nm	0.17	0.04
Iron	24.4	14.5	10.0	8.8
Zinc	0.43	Nm	0.28	Nm

Note: Nm = Not measured

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Getlini Eko Landfill

- Biocells for Riga, Latvia

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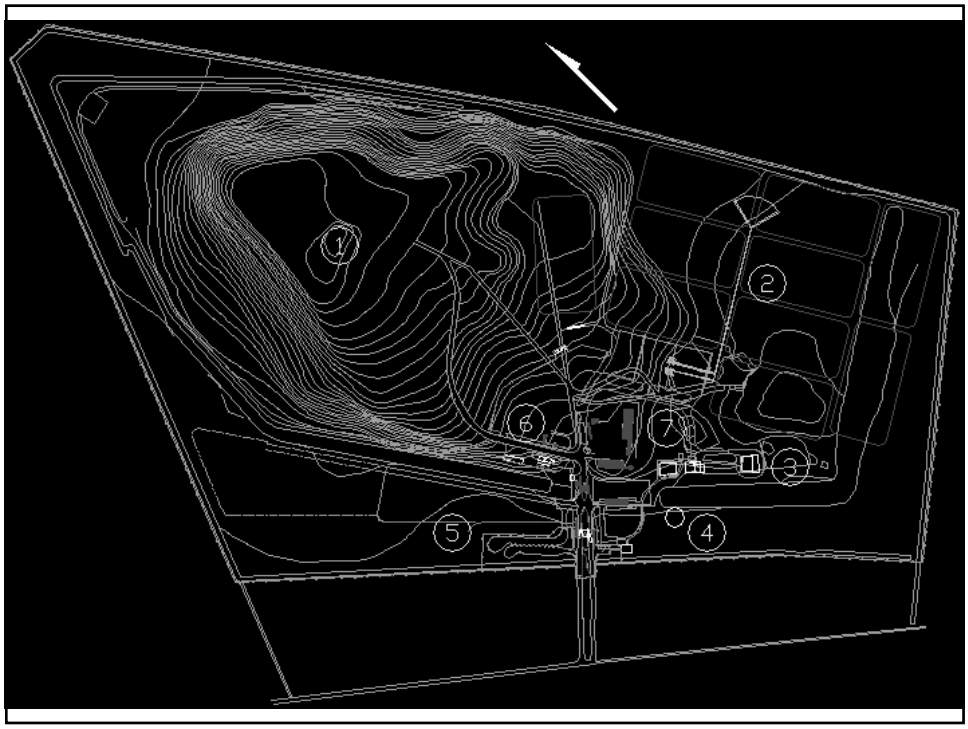

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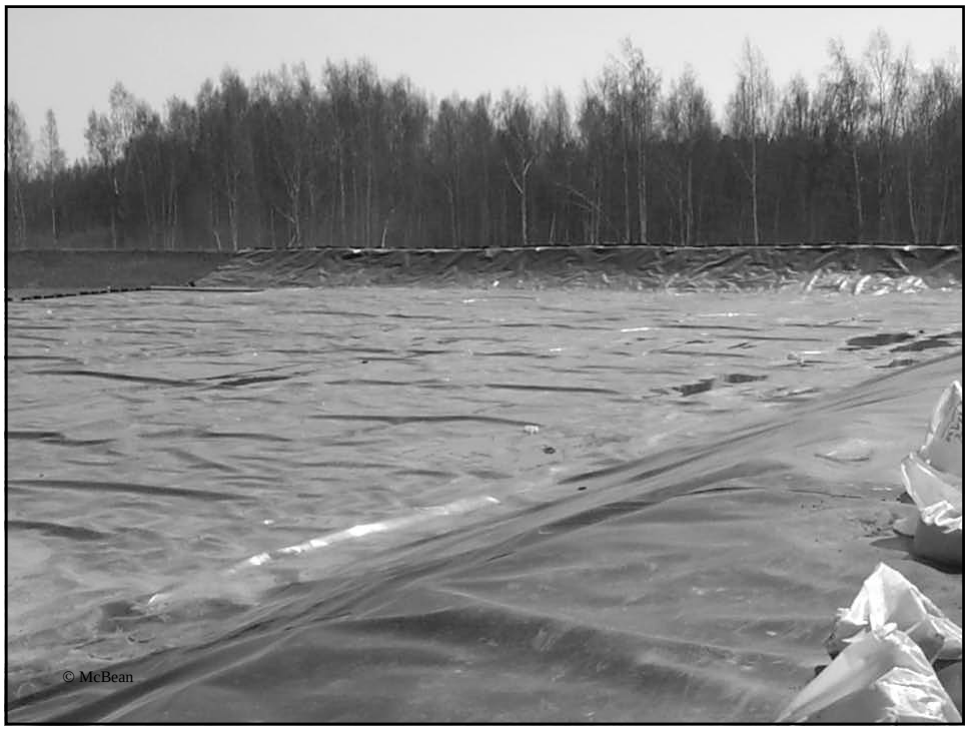

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Numerous gas collection methodologies

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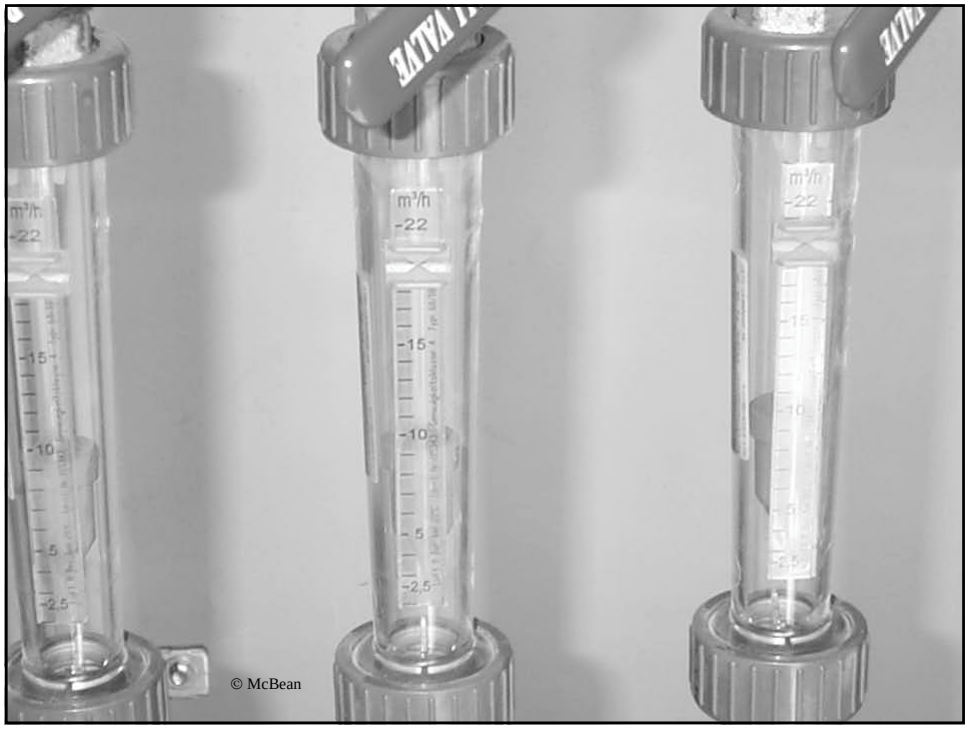
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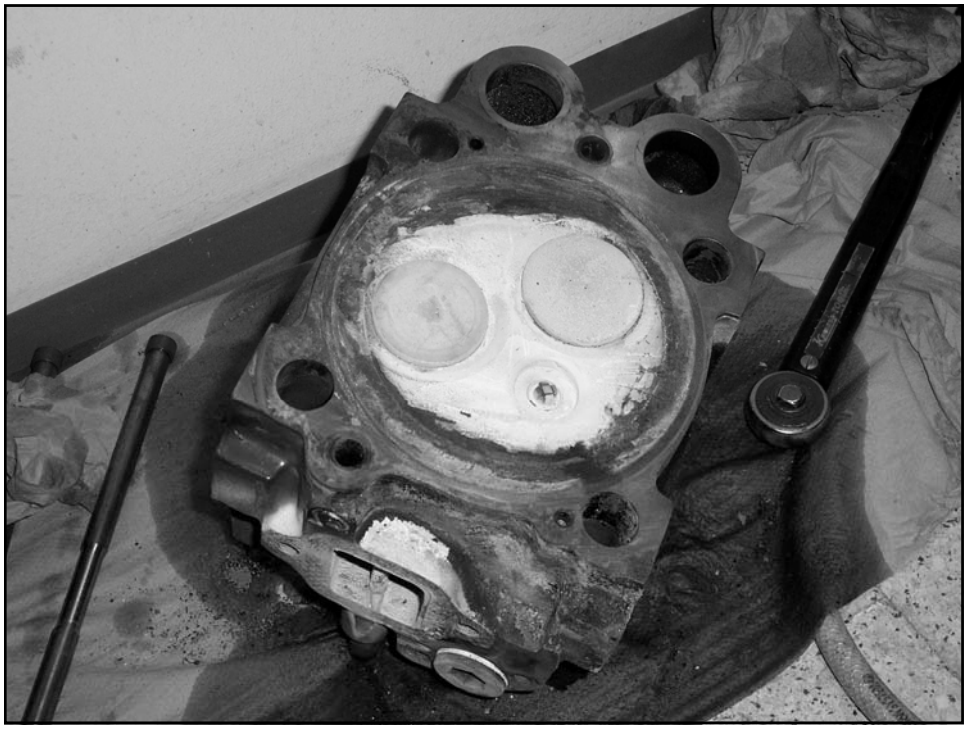

- Questions?

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