PTS Job 22974A

ENZYME FLUID IFT TEST REPORT
(5% and 2% Enzyme Solutions)

Prepared for:

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INTERFACIAL / SURFACE TENSION REPORT

(METHODOLOGY: DuNuoy Method - ASTM D971)

DATE: June 2010
PROJECT NAME: Jumpstart
PROJECT NO: 22974 A

PHASE PAIR		TEMP.,	INTERFACIAL TENSION,
SAMPLE ID / PHASE	SAMPLE ID / PHASE	(°F)	(Dynes/centimeter)
DI Water	Air	76.0	73.32
NAPL	Air	76.0	27.55
DI Water	NAPL	76.0	25.39
Tigerzyme 21E (5%)	Air	76.0	36.47
Tigerzyme 21E (5%)	NAPL	76.0	6.17
Tigerzyme 22E (5%)	Air	76.0	33.83
Tigerzyme 22E (5%)	NAPL	76.0	4.31
Stimuzyme D200 (5%)	Air	76.0	50.10
Stimuzyme D200 (5%)	NAPL	76.0	3.41
Tigerzyme 22E (2%)	Air	73.0	34.86
Tigerzyme 22E (2%)	NAPL	73.0	5.13

APPENDIX
Test Description and Data

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DETERMINATION OF INTERFACIAL TENSION BY THE RING METHOD

Description of Method

Surface tension is a molecular property of liquids which produces certain phenomena at interfaces (e.g., liquid-liquid, gas-liquid). It is a "skin effect" similar to a stretched membrane. In the case of surface tension separating two different liquids the effect is called interfacial tension (IFT).

When an IFT measurement is to be made at an interface between an aqueous-based liquid and a liquid lighter in density, a measured force to pull a thin wire ring through the interface can be used to determine IFT. This method is commonly referred to as the du Nouy, or "Ring Method."[1,2] Starting with the aqueous phase in a clean vessel (beaker or dish), a quantity of the less-dense liquid is carefully poured above the surface of the aqueous phase. The thin wire ring is initially placed below the interface of the two liquids and the force necessary to withdraw it upward through the interface is measured. In this process, the ring is raised and the surface is distorted as the upward movement of the ring continues. Subsequently, a rupture occurs where the two surfaces meet, termed the "breaking point." Certain physical phenomenon occur during the process (such as liquid film clinging to the ring) that require consideration during the calculation of the true interfacial tension. Details of the method as carried out in the laboratory can be found in the references, particularly Ref. 2.

References

1. du Nouy, P. L.: "An Interfacial Tensiometer for Universal Use," Laboratories of The Rockefeller Institute for Medical Research, Plate 5 (April 6, 1925), online at jgp.rupress.org.
2. ASTM D971 for detailed method description.

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INTERFACIAL TENSION
DuNuoy Method

CALCULATION SUMMARY SHEET

DATE	SAMPLE PAIR		TEMP.,	D	d	p	RING	RING		CORRECTION	
	Denser of the pair	Less Dense of the Pair	°F	DENSITY 1	DENSITY 2	IFT READING	NO.	CALIB.	p/(D-d)	FACTOR, f	IFT, Dynes/cm
06/24/10	DI Water	Air	76.0	0.9972	0.0012	78.10	6	53.6	78.41	0.9388	73.32
06/24/10	NAPL	Air	76.0	0.9377	0.0012	30.90	6	53.6	32.99	0.8915	27.55
06/24/10	DI Water	NAPL	76.0	0.9974	0.9377	22.40	6	53.6	375.21	1.1335	25.39
06/24/10	Tigerzyme 21E (5%)	Air	76.0	0.9974	0.0012	40.50	6	53.6	40.65	0.9005	36.47
06/24/10	Tigerzyme 21E (5%)	NAPL	76.0	0.9974	0.9377	6.40	6	53.6	107.20	0.9638	6.17
06/24/10	Tigerzyme 22E (5%)	Air	76.0	0.9972	0.0012	37.70	6	53.6	37.85	0.8973	33.83
06/24/10	Tigerzyme 22E (5%)	NAPL	76.0	0.9972	0.9377	4.60	6	53.6	77.31	0.9378	4.31
06/24/10	Stimuzyme D200 (5%)	Air	76.0	0.9983	0.0012	54.70	6	53.6	54.86	0.9159	50.10
06/24/10	Stimuzyme D200 (5%)	NAPL	76.0	0.9983	0.9377	3.70	6	53.6	61.06	0.9222	3.41
06/25/10	Tigerzyme 22E (2%)	Air	73.0	0.9969	0.0012	38.80	6	53.6	38.97	0.8986	34.86
06/25/10	Tigerzyme 22E (2%)	NAPL	73.0	0.9969	0.9377	5.40	6	53.6	91.22	0.9503	5.13