Universitat Autònoma de Barcelona

TECHNICAL NOTE 94.62

Call Off Order 3 – COMPARTMENT I Additional Characterization

Work Package 94.6

Test Protocol – Nominal operation (10 days HRT)

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Reference/Réference	MELiSSA Pilot Plant Frame Contract 19445/05/NL/CP
Issue/Edition	0
Revision/Révision	0
Date of issue/Date d'édition	13/10/11
Status/Statut	Final

APPROVAL

Title / Titre	Test Protocol for nominal operation with 10 days HRT	Issue / Edition	0	Revision / Révision	0

Prepared by / Auteur	A. Fossen	Date / Date	25/01/12
Checked by / Verifié par	E. Peiro	Date / Date	06/02/2012
Approved by / Approuvé par	F.Gòdia	Date / Date	08/02/2012
Approved by customer / Approuvé par le client	B. Lamaze	Date / Date	05/10/2012

CHANGE LOG

Issue/Edition	Revision/*Révision*	Status/*Statut*	Date/*Date*
0	0	Final	05/10/2012

Distribution List

Name/*Nom*	Company/*Société*	Quantity/*Quantité*
Brigitte LAMAZE	ESA	2 hardcopies + electronic version
Technical Team	MPP	1 copy in QP 0007
Overall Manager	MPP	1 copy in QC1119
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1. Scope

In the frame of Call Off Order 3, the objective of this document is to summarize the protocol to follow in order to perform the third phase of the characterization tests of Compartment 1, namely the phase of nominal operation at 10 days of hydraulic residence time.

2. Applicable and reference documents

2.1. Applicable documents

Ref.	Title	Reference	Issue	Date
AD1	MPP Proposal for Call Off Order 3 – C1 additional characterization	OFR-ESA-03/07-UAB	1	30/11/07
AD2	MPP Quality Manual	MPP-QA-07-0001	2	
AD3	MPP Rules for Good Laboratory Practices	MPP-QA-07-0003	0	
AD4	Test Plan for C1 additional characterization tests	TN94.5	0	
AD5	PID of Compartment 1	MPP-PID-10-1001	B3	5/10/2011
AD6	MPP Operation Manual for C1	MPP-OP-12-1001	0	9/2/2012
AD7	C1 Acceptance Review Datapackage including HMI and PLC software user manuals	DP94.1	1	October 11
AD8	MPP Maintenance Manual for C1	MPP-UM-11-1001	0	
AD9	Sampling and analyses plan and protocol for nominal conditions	TN94.22		
AD10	Operating procedure for grinding and mixing of C1 bioreactor feed with the WPU	MPP-OP-10-1002	0	6/2/12

2.2. Reference documents

Ref.	Title	Reference	Issue	Date
RD1	TN 94.11 Compartment I Integration in MPP	TN 94.11	0	13.02.09
RD2	HAZOP on Compartment 1	MPP-TN-08-1001	0	01/09/2008
RD3	Gas Chromatograph User Manual	MPP-UM-09-0009	1	23.10.06
RD4	Portable Gas Analyzer User Manual	MPP-UM-09-0012	0	
RD5	TN 83.7 Expertise of level 0 control loops on the 100 L pilot reactor	TN 83.7	1	23.10.06
RD6	Minutes of meeting MPP/UBP on C1 characterization	MPP-MOM-08-1007	0	16.04.2008
RD7	EPAS EWC User Manual	User Manual	1	12.06.07
RD8	Functional tests report of C1	TN94.12		

3. Acronyms and definitions

CI : compartment I
MELiSSA: Micro-Ecological Life Support System Alternative
UAB: Universitat Autònoma de Barcelona
VFA: volatile fatty acids
BR: bioreactor
FU: Filtration unit
GL: Gas loop
SFC: Sequential function chart
HMI: human interface
ICP-MS : Induced Coupled Plasma Mass Spectrometry
CST : capillary suction time
HRT: hydraulic residence time, equivalent to liquid residence time
TRR test readiness review
TAR test acceptance review

4. Test items

4.1. Description (PID, technical drawings, user manual)

The compartment 1 was delivered in the MPP and installed as described in RD1.
It consists of 3 subunits or modules that are described on the PID AD5 and in the User Manual AD6, namely :

- The bioreactor and influent tank skid
- The gas loop skid
- The filtration unit skid

The system is operated automatically from a programmable logical controller (PLC) as described in AD7.

4.2. Hazards induced by test item and safety measures to be taken

As explained in the hazard and operability study carried out on compartment 1 (cf. RD2), the main hazards induced by the operation of compartment 1 are:

- pressure (gas: up to 3 barg, liquid: up to 5 barg)
- temperature (steam sterilization)
- chemical (acid/base for pH control)
- biological (biohazard level 2 as a maximum when using faeces for the feeding of C1)
- flammable gases (H2, CH4) ;

The adequate individual protection measures shall be taken by the operators in order to limit the exposure to these hazards. As detailed in AD4, these measures include :

- wearing of a labcoat
- wearing of safety goggles
- wearing of gloves when manipulating materials or equipments
- respect of the user and maintenance instructions, in particular the respect of the confined and anaerobic conditions in the bioreactor

4.3. Instructions for operation

See AD6, AD7, AD8 and RD7

4.4. Instructions for maintenance

See AD6, AD7, AD8 and RD7

5. Recall of the test sequence

The call off order 3 characterization tests sequence can be summarized as follows :

- Phase 1 : maintenance of the inoculum, 20 days HRT
- Phase 2 : ramp-up of the culture in the C1 bioreactor up to continuous conditions, HRT evolving from 20 days up to10 days, reaching a dry matter content between 40g/L and 70g/L
- Phase 3 : 10 days liquid residence time test
- Phase 4 : 7 days liquid residence time test
- Phase 5 : 13 days liquid residence time test
- Phase 6 : 3 to 5 days liquid residence time test

The present protocol is dedicated to the phase 3 after recovery of the inoculum and ramping up of the culture up to a dry matter content between 40g/L and 70g/L.

The phase 3 can be split into two phases: transient phase for the establishment of 10 days HRT steady state and steady state at 10 days HRT.

In order to determine that the steady state is established, the culture is operated as per the present protocol and samplings and analyses are carried out as per AD9. During this transient period, the main analyses performed are on the following four steady state indicators of the bioreactor:

- Bioreactor dry matter content
- Total Chemical Oxygen Demand (CODtot)
- CO2 production rate
- VFA production rate and, for information, the ratio between the various VFAs compounds

The steady state is reached when these four indicators are stable over a period of 3 HRT , ie 30 days.
Once this steady state is reached,it is maintained over at least 1 HRT, to allow more extensive samplings and analyses, as per AD9.

See the diagram below to illustrate the logic to be followed during the 10 days HRT test.

6. Test protocol

6.1. Requirements addressed by the test

The following requirements were discussed between ESA and UBP on 29/01/2007 for compartment 1 ; they are not completely finalized but are the best available to date:

Requirement number						Requirement description	Applicability
2						Subsystem requirements	
2	1					Functional requirements	
2	1	1				Wastes treatment system = (C1+Fiber Degradation Unit+Wastes Preparation Unit+Wastes Collector Unit)	A
2	1	1	1			The WTS shall handle the solid wastes from the mission	A
2	1	1	2			The WTS shall handle the liquid wastes from the mission	A
2	1	1	2	1		The WTS shall handle the toilet flush of the mission	N/A
2	1	1	2	2		The WTS shall handle the urine of the mission	N/A
2	1	1	3			The WTS shall degrade the wastes from the mission	A
						The WTS shall degrade the proteins of the wastes	A
						The WTS shall degrade the lipids of the wastes	A
						The WTS shall degrade the carbohydrates of the wastes	A
						The WTS shall degrade the fibers of the wastes	A
2	1	1	4			The WTS shall produce chemicals that can be used directly by the CIVa and CIVb	A
				1		CO2	A
				2		minerals	A
				3		NH4+	A
						The WTS shall limit the chemicals that cannot be used directly or indirectly by the CIVa and CIVb	A
						CH4	A
						H2S	A
						gas contaminants (analysis by M. Quemener)	A
						H2	A

2	1	1	5			The WTS shall produce chemicals that can be used indirectly by the CIVa and CIVb	A
				1		VFAs	A
				2		NH4+	A
				3		carbonates and bicarbonates	A
						The chemicals produced by WTS that can be used directly by the CIVa and CIVb shall be considered for the ALISSE multi criteria approach	N/A
						The WTS shall optimize the degradation of wastes into chemicals that can be used directly by the CIVa and CIVb in accordance with ALISSE multi criteria approach	A
2	1	1	4			The wastes compartment shall fulfill the biosafety requirements	A
2	1	1	5			The wastes compartment shall handle all products that cannot be used by other compartments or units (e.g. ashes, CH4, H2S,…)	A
2	1	1	6			The WTS shall deliver sterile output to other compartments (is it included in the biosafety requirements?)	A
2	1	1	7			The wastes compartment shall allow for all necessary steps of phase separation (gas, liquid, solid)	A

Among these requirements, the following ones are to be addressed through the characterization test plan TN94.5 and the test protocol TN94.62 :

- Degradation of organic matter into CO2, ammonium and volatile fatty acids
- Yield of this degradation
- Production of a sterile filtrate by the filtration unit

6.2. Features to be tested : functions, hardware, software

The hardware and software functionalities have been tested in previous tests from COO3, as summarized in RD8 and AD7.

The features to be tested during the nominal operation of compartment 1 are explained in AD4. For this phase of 10 days HRT, they are mainly the characteristics of the process itself, when maintained in a steady state as a continuously stirred tank reactor with perfusion and in the specified operating conditions during at least 3 hydraulic residence times ie 30days.

In particular, the following features shall be demonstrated during the tests

1. Maintenance of the nominal process conditions in terms of temperature, pH, dry matter content, anaerobiosis (absence of O2 in the gas phase), feeding composition, feeding particle size, sterility of the filtrate output, during the whole test.
2. Continuity of feeding regime according to the established RT
3. Continuity of filtration regime according to the established RT
4. Continuity of biogas production, with limited CH4, SH2 and H2 production
5. Continuity and production level of the main products of C1 fermentation process :
    - VFA production rate
    - NH4+ production rate
    - CO2 production rate
6. Evolution of relevant analytical values (elemental analysis, minerals, protein, fibers, etc.) measured according to AD9
7. Long-term performance of the optimised filtration membrane for the 10days HRT period.

6.3. Success/failure criteria

The characterization test is considered successful if steady state is achieved and further characterized, and if all the expected data have been collected as per AD9 over both the transient and steady state phases.

The detail of the success/failure criteria is available in AD4.

6.4. Resources specification for the tests

6.4.1. Personnel: staff qualification and training needs

The MPP technicians are qualified to operate the C1 compartment.

The MPP Analysis Technicians are qualified to perform the sampling operations and the MPP in-house analyses (cf. appendix 1)

6.4.2. Hardware: instruments, specific part, hardware for software operation

C1 Hardware as described in AD6

The portable gas analyzer GA94 as described in RD4.

The gas chromatograph is used for VFA measurement. It is described in RD 3

The preparation of the samples is made with a lyophilizer and other equipments of common use in the Chemical Engineering Dpt.

6.4.3. Software : verification of software, backup needs

The C1 software was verified and validated by different functional tests the outcome of which is detailed in AD7 (and RD8). The last versions of the program and hardware used for control are described in AD7.

The software used is the Schneider Concept V2.6. for C1 control.

No special backup is needed for these tests apart of the nominal server backup. Concerning backup of data, the collected data collected by the MPP server are saved on a weekly basis onto an external drive.

6.4.4. Facilities : environmental needs, test conditions, interfaces needs, utilities needs

All hardware involved in MPP utilities for C1 as specified in AD6 and AD5.

In particular the decalcified water is necessary for the cleaning in place tasks, steam is necessary for the sterilization tasks, compressed air is necessary for operation of all pneumatically actuated valves.
The room of C1 is maintained in underpressure as compared to the axenic compartments room.

6.4.5. Test conditions

The following conditions should be maintained on the Compartment 1 process for the 10 days liquid residence time :

C1 BIOREACTOR - HMI							
Emergency button		(ON/OFF)	OFF	Agitation	BLE_1012_01	(ON/OFF)	ON
pH sensor 1 (main)	AT_1011_01	(-)	5,2-5,4	Level	VSL2_1007_01_VOL	(L)	95-105
pH sensor 2 (backup)	AT_1011_02	(-)	5,2-5,4	Headspace Pressure	PT_1009_01	(mbar)	75-100
Average pH	AT_1011_AVE	(-)	5,2-5,4	Temperature	TT_1008_01_AV	(°C)	54-56

INFLUENT TANK - HMI							
Recirculation pump	BLF_1005_01	(ON/OFF)	ON	Level	VSL2_1000_01_VOL	(L)	10-55
Blender	BLE_1005_01	(ON/OFF)	ON	Temperature	TT_1002_AVE	(°C)	6-12
Pressure	PT_1003_01	(mbar)	110-130	Calculated feed flow rate		(L/day)	5-20

FILTRATION UNIT - HMI							
Filtration Unit Operation Mode: Bypass / Filtration (B/F)			B/F	Effluent Filter Press.	PT_1203_08	(bar)	0-0,5
Circulation Flow	FT_1201_01	(L/h)	440-460	Effluent Tank Temp.	TT_1205_01	(°C)	10-20
Filtration Membrane in Use		(1 / 2)	1/2	Effluent Filtr. Volume	VSL2_1204_01_VOL	(L)	4-20
Membrane in use Temp.	TT_1200_02 / 03	(°C)	50-60	Volume of Filtrate emptied		(L)	0-20
Trans-Membr. Pressure	CL1203_TMP1 / 2	(bar)	0,1-0,2	Daily Filtrate Production (calculated value)		(L/day)	5-20

GAS LOOP - HMI							
Active Gas Loop System		(ON/OFF)	ON	CO_2 concentration (off-line)		(%)	50-80
Cooler	HX_1102_01	(ON/OFF)	ON	CH_4 concentration (off-line)		(%)	0-2
Condensates pump	PP_1102_01	(ON/OFF)	ON	O_2 concentration (off-line)		(%)	0-1
CO_2 concentration	AT_1101_01	(%)	50-80	H_2 concentration (off-line)		(ppm)	>1000 ①
CH_4 concentration	AT_1101_02	(%)	0-2	H_2S concentration (off-line)		(ppm)	<1000

C1 ROOM GENERAL							
Observed level of 3 M HCl Bottle		(mL)	≤ 1000	Observed level of 3 M NaOH Bottle		(mL)	≤ 1000
Added volume of 3 M HCl		(mL)	≤ 1000	Added volume of 3 M NaOH		(mL)	≤ 1000
Hot bath VSSL_1008_01 filled with water?		(yes/no)	YES/NO	Hot bath temperature	TT_1008_01_AV	(°C)	58-62

REMARKS
① EPAS reported up to 50.000 ppm

6.4.6. Rationale to determine the bleeding volume

The dry matter is controlled by making a regular bleeding in order to drain the solids that might accumulate in this continuously stirred tank reactor with perfusion.
First, the feeding flow F is imposed by the liquid residence time expected in the bioreactor and the volume of the bioreactor.
Secondly, in order to assess the bleeding flow D to be used to stabilize the solids content, a mass balance is performed on the bioreactor. The flow of permeate P to be produced through the membrane is then calculated, as explained in the equations below

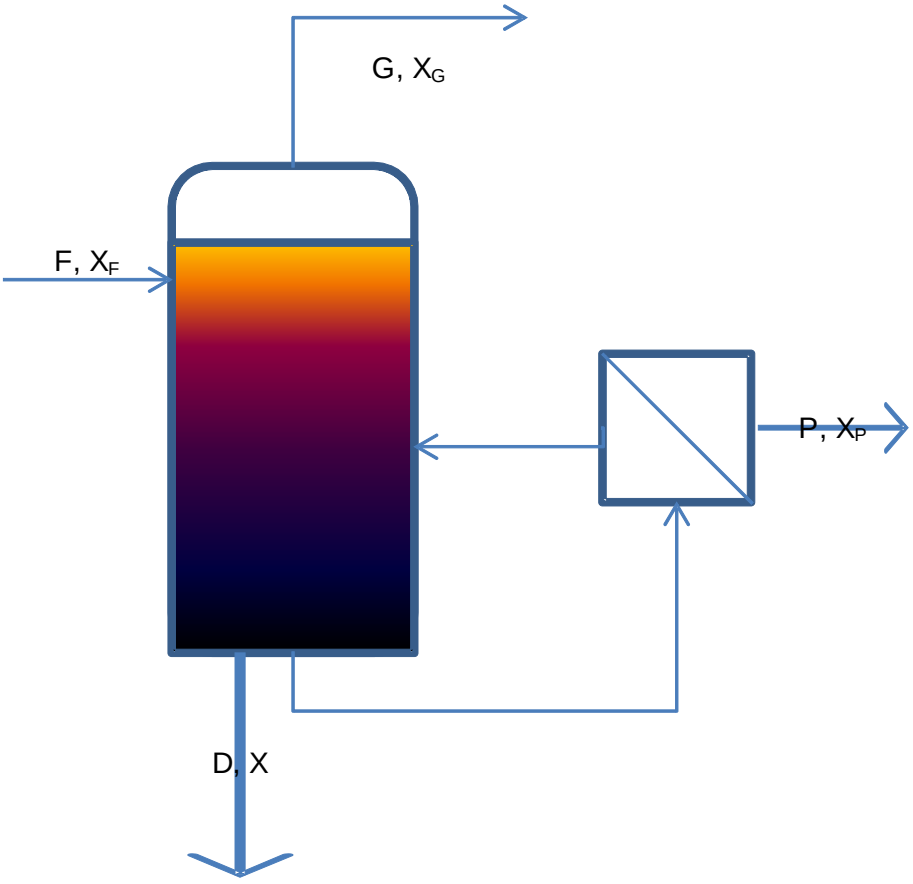

Ilustración 1 – Mass balance on C1 bioreactor

F, P, D, G : volumetric flows from feeding, permeate, drain, gas (in L/d)
X, X_F, X_P, X_G: dry matter concentration (in g/L) in bioreactor, feeding, permeate, gas flows
$X_{setpoint}$: the expected dry matter content of the bioreactor
V : volume of the bioreactor (in L)

Since the massic flow of gas is much lower than the massic flows of liquid, and the densities of the liquids are all close to 1, the mass conservation equation yields the following volume conservation equation :

$$\frac{dV}{dt} = F - P - D$$ Equation 1 - bioreactor liquid volume balance

As the content of dry matter in the gas X_G is negligible as compared to the dry matter content of liquids, the mass conservation of dry matter can be written as follows :

$$V.\frac{dX}{dt} + X.\frac{dV}{dt} = Production\ rate(X) + F.X_F - P.X_P - D.X$$ Equation 2 - bioreactor dry matter balance

When the volume is constant, $P = F - D$
When the volume and the dry matter content of the bioreactor are constant, and assuming in a first approach that there is no transformation of the dry matter (production rate of dry matter is null) :

$$D = \frac{F.(X_F - X_P)}{X_{setpoint} - X_P}$$ Equation 3 - bleeding flow for stable dry matter

As no continuous bleeding is made on the current hardware, the punctual bleedings made are calculated so that their volume and frequency match the theoretical continuous bleeding flow D.

The calculated bleeding volume is then specified on the follow-up record sheet for implementation.

7. Measurement and data sampling

7.1. Data logfile

The daily operations on the compartment 1 are recorded in the follow-up record sheets that constitute the as-run procedures for this test.
In parallel, all the operational parameters are recorded by the MPP server and saved onto the MPP database.

The samplings and analyses are performed routinely and are recorded in written on dedicated record sheet, internal or external to the MPP, as per AD9.

These raw data of follow-up and analyses are then typed into the C1 database for analyses.

7.2. Special requirements if any (frequency, duration, synchronization)

The operational parameters should be recorded at a periodicity of 5 minutes.

7.3. Reporting of status for a test

On a monthly basis, the BioProcess Engineer or the Technical Manager reviews the raw data, checks the trends and spots the inconsistent values.

At the end of the test phase (here the 10 days HRT test), or at least every 3 months, a report is compiled with all the analyses results related to the same test phase and sent by the Technical Manager to the partners..

7.4. Deviations and non conformances

In case the test sequence cannot be performed as planned or the results are not fulfilling the expectations, a deviation is opened and appended to the test record.
The deviation is discussed between UAB and ESA to decide on how to address it. In any case, all deviations will be discussed before a decision is taken on the status for the test

In the case that a Non conformity is derived from any of the deviations, the MPP procedure for non conformities management will be followed (MPP-QAP-08-0002)

7.5. Record for the test procedure

As this protocol is contemplating a routine steady state operation, the proposed procedure is to follow a daily monitoring of the main parameters of operation while recording all the instruments acquired data on the MPP server.

The values of the main operating parameters of compartment 1 are filled out by the operator at least 5 days a week, knowing that the missing days can be inferred from the acquired data.

7.5.1. Records of samplings

The samplings are recorded as per AD9

7.5.2. Records of analyses

Various MPP records are used to trace the results of the analyses on C1 samples as per AD9

7.5.3. Records for feed preparation

The lots number and quantities of mixed ingredients as well as the various steps of preparation are traced in the record MPP-REC-11-1002, a specimen of which is displayed in appendix 1.

7.5.4. Records of follow-up of operational parameters

The values of the main operating parameters of compartment 1 are filled out by the operator in the record MPP-REC-10-1001, a specimen of which is displayed in appendix 2.

7.5.5. C1 logbook

In case some operations that are not considered in the routine follow-up record have to performed, they are traced in the C1 logbook MPP-ILB-10-1001, that is filled out handwriting.

8. Appendix 1 - Record for C1 feed preparation

MELiSSA Pilot Plant

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Document Identification: Record Sheet for Grinding and Mixing of C1 Bioreactor Feed with the Waste Preparation Unit	Type	Reference	Chrono	Page: 1 / 2
	MPP-REC	11-1002(0)	__ __	

COMPARTMENT: C1	
Applicable Operating Procedure:	MPP-OP-10-1002(0) Grinding and Mixing of C1 Bioreactor Feed with the Waste Preparation Unit
Hardware:	Waste Preparation Unit and C1 Influent Tank

1. MATERIALS PREPARATION

Feed Preparation Volume: ☐ 35 L ☐ 70 L

HUMAN FAECES								*VEGETABLES*		
Donor Code	Don. Date (dd/mm/yy)	Freezer drawer	Weight (g)	Donor Code	Don. Date (dd/mm/yy)	Freezer drawer	Weight (g)	Bag No.	Lot	Weight (kg)
								Veget. thawed from (dd/mm/yy): ____/____/____ Temp. (℃): ____		

Human faeces weight (kg)	
Vegetables weight (kg)	
Total materials weight (kg)	

Date (dd/mm/yy): ____/____/____

Initials: _____

2. FEED MILLING

☐ WPU filled with initial water (L): _____

☐ Faeces added to WPU

Time for thawing faeces (min): _____

☐ Vegetables added to WPU

☐ Final volume completed with water (L): _____

☐ Decontamination with NaClO

Cooling of the WPU? ☐ yes ☐ no

☐ Start of milling at (hh/mm): ____/____

☐ End of milling at (hh/mm): ____/____

Total milling time (min): _____

Date (dd/mm/yy): ____/____/____ Initials: ____

3. FEED TRANSFER

☐ Valve H3V_1001_01 in position for Transfer

☐ N_2 supply valve HV_1302_02 to Influent Tank is closed

☐ Top port of Influent vessel is opened

☐ Manual valve HV_1302_02 is opened

☐ Solenoid valve S3V_1001_01 selected for Manual Mode at HMI

☐ Bioreactor Feeding Operation Mode to MANUAL

☐ Exhaust air valve HV_1302_01 closed

☐ Pressure at PI_1302_02 sensor ~ 0.1 MPa

Feed passing to Influent Tank? ☐ yes ☐ no

Transferred volume of feed (L): _____

☐ Bioreactor Feeding Operation Mode to AUTO

Date (dd/mm/yy): ____/____/____ Initials: ____

MELiSSA Pilot Plant

Document Identification: Record Sheet for Grinding and Mixing of C1 Bioreactor Feed with the Waste Preparation Unit	Type	Reference	Chrono	Page: 2 / 2
	MPP-REC	11-1002(0)	__ __	

4. RINSING OF REMAINING FEED

NOTE: Fill this section only if Feed Preparation Volume is 35 L.

☐ Bottom valve HV_1305_02 closed
☐ Deionized water for rinsing added (L): ____
☐ Rinsing started at (hh/mm): ____/____
☐ Rinsing ended at (hh/mm): ____/____
Total rinsing time (min): _____
☐ Bottom valve HV_1305_02 opened

☐ Pressure at PI_1302_02 sensor ~ 0.1 MPa
☐ Bioreactor Feeding Oper. Mode to MANUAL
Rinsing volume transferred to Influent Tank?
☐ yes ☐ no
Transferred volume (L): _____
Date (dd/mm/yy): ____/____/____ Initials: ____

5. CLEANING

☐ Top port of Influent tank closed
☐ Bioreactor Feeding Operation Mode to AUTO
☐ N_2 supply valve HV_1302_02 to Influent Tank is opened
☐ Bottom valve HV_1305_02 closed
☐ Initial decalcified water added (L): _____
☐ 5 M NaOH added (L): _____
Lot of 5 M NaOH solution: _____
☐ Final volume with decalcified water (L): _____
☐ Start of cleaning at (hh/mm): ____/____
☐ End of cleaning at (hh/mm): ____/____
Total cleaning time (min): _____

☐ 85% H_3PO_4 added (mL): _____
☐ Start of neutralization at (hh/mm): ____/____
☐ End of neutralization at (hh/mm): ____/____
Total neutralization time (min): _____
☐ Valve H3V_1001_01 in position for discharge
☐ Pressure at PI_1302_02 sensor ~ 0.1 MPa
☐ Bottom valve HV_1305_02 opened
pH of neutralized cleaning solution: _____
☐ pH-meter U00330 ☐ Other: _____
Cleaning solution discharged? ☐ yes ☐ no
Date (dd/mm/yy): ____/____/____ Initials: ____

6. FINAL RINSING

☐ Bottom valve HV_1305_02 closed
☐ Addition of decalcified water (L): _____
☐ Start of rinsing at (hh/mm): ____/____
☐ End of rinsing at (hh/mm): ____/____
Total rinsing time (min): _____

☐ Pressure at PI_1302_02 sensor ~ 0.1 MPa
☐ Bottom valve HV_1305_02 opened
pH of final rinsing solution: _____
☐ pH-meter U00330 ☐ Other: _____
Final rinsing water discharged? ☐ yes ☐ no
Date (dd/mm/yy): ____/____/____ Initials: ____

7. REMARKS

9. Appendix 2 - Record for C1 follow-up

MELiSSA Pilot Plant				
Document Identification: *C1 Bioreactor Follow-up Record Sheet*	Type	Reference	Chrono	Page : 1 / 1
	MPP-REC	10-1001 (1)		

Analyst:	
Date (dd/mm/yy):	
Hour (hh:mm):	

Checked by:	
Date (dd/mm/yy):	

C1 BIOREACTOR - HMI							
Emergency button		(ON/OFF)		Agitation	BLE_1012_01	(ON/OFF)	
pH sensor 1 (main)	AT_1011_01	(-)		Level	VSL2_1007_01_VOL	(L)	
pH sensor 2 (backup)	AT_1011_02	(-)		Headspace Pressure	PT_1009_01	(mbar)	
Average pH	AT_1011_AVE	(-)		Temperature	TT_1008_01_AV	(°C)	

INFLUENT TANK - HMI							
Recirculation pump	BLE_1005_01	(ON/OFF)		Level	VSL2_1000_01_VOL	(L)	
Blender	BLE_1005_01	(ON/OFF)		Temperature	TT_1002_AVE	(°C)	
Pressure	PT_1003_01	(mbar)		Calculated feed flow rate		(L/day)	

FILTRATION UNIT - HMI							
Filtration Unit Operation Mode: Bypass / Filtration (B/F)				Effluent Filter Press.	PT_1203_08	(bar)	
Circulation Flow	FT_1201_01	(L/h)		Effluent Tank Temp.	TT_1205_01	(°C)	
Filtration Membrane in Use		(1 / 2)		Effluent Filtr. Volume	VSL2_1204_01_VOL	(L)	
Membrane in use Temp.	TT_1200_02 / 03	(°C)		Volume of Filtrate emptied		(L)	
Trans-Membr. Pressure	CL1203_TMP1 / 2	(bar)		Daily Filtrate Production (calculated value)		(L/day)	

GAS LOOP - HMI							
Active Gas Loop System		(ON/OFF)		CO_2 concentration (off-line)		(%)	
Cooler	HX_1102_01	(ON/OFF)		CH_4 concentration (off-line)		(%)	
Condensates pump	PP_1102_01	(ON/OFF)		O_2 concentration (off-line)		(%)	
CO_2 concentration	AT_1101_01	(%)		H_2 concentration (off-line)		(ppm)	
CH_4 concentration	AT_1101_02	(%)		H_2S concentration (off-line)		(ppm)	

C1 ROOM GENERAL							
Observed level of 3 M HCl Bottle		(mL)		Observed level of 3 M NaOH Bottle		(mL)	
Added volume of 3 M HCl		(mL)		Added volume of 3 M NaOH		(mL)	
Hot bath VSSL_1008_01 filled with water?		(yes/no)		Hot bath temperature	TT_1008_01_AV	(°C)	

REMARKS