Supplementary Materials: Measuring Surface and Interfacial Tension In Situ in Microdripping Mode for Electrohydrodynamic Applications

Karim I. Budhwani, Gerald M. Pekmezi and Mohamed M. Selim

1. Experimental Materials and Methods

Minor changes were made to setup described in earlier studies. A KDS-410 (kdScientific®, Holliston, MA) syringe-pump was connected to stainless steel 14g needle (1.600/2.108 mm inner/outer diameter. Ramé-hart co.) using 1/16" Tygon® tubing. A Teledyne Dalsa Genie® CR-GM00-H6401 camera fitted with 10x macro lens was connected to a computer running custom LabView® 2016 (Vision Acquisition Software® 2017, and Vision Development Module® 2016) and MATLAB 2017a (MathWorks®) programs. Parameters such as nozzle diameter, flowrate, density, and viscosity were configured for a low Weber number. Droplet frequencies near 1-5 Hz minimize computational resources and control experimental variance. Conditions such as atmospheric saturation, nozzle-plane leveling, and surrounding vibration were monitored. Ethanol (70% v/v) purchased from Ricca Chemical Company (Arlington, TX). Molecular-biology-grade chloroform and non-ionic surfactant Tween® 20 purchased from Fisher Scientific (Fair Lawn, NJ). All experiments were at least performed in triplicate. At least 3 measurements were made for all experimental observations.

2. Function dkAnalyze (MATLAB® Script)

MATLAB® script encoding drop-kick algorithm for analyzing signals derived from both CFD output and CCD video.

```
function [hzDrops, sdDrops, hzWsd, wsdHarmonic, hzFft, fftHarmonic] =
dkAnalyze(peakSignal, rawSignal, fps, pathName, fileName)
% function dkAnalyze(peakSignal, rawSignal, fps, pathName, fileName)
%
% Calculate periodicity and DK frequencies for input signal "rawSignal"
% recorded at "fps" frame rate (sampling frequency) using multiple
% algorithms. Start with average drop rate from "peakSignal". Plot results
% from each algorithm on a single side-by-side figure (saved as "fileName"
% in folder "pathName") for a quick visual analytical and validation view
% of drop kinetics and periodicity.
% Spectral analysis algorithms: Welch's power spectral density and FFT.

% 1. Initialize variables
% 1a. Length of signal (# of images)
L = length(peakSignal);

% 1b. % Next power of 2 from 100 times signal length to produce output with
% more frequency bins closely spaced for higher resolution.
NFFT = 2^nextpow2(L*100);

% 1c. Handle to figure
hFigure = figure;
hFigure.Position = [100 300 1200 400];
```

```
% o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o

% 2. Count the drops
signalPeaks = peakSignal;                    % Use peak highlighted signal
[~, dropLocs] = findpeaks( signalPeaks );    % Get locations of those peaks
if(length(dropLocs)>14)
    dropLocs = dropLocs(2:length(dropLocs)-1);  % Skip first and last drops
end
locDiffs = sort(diff(dropLocs));             % Compute and sort drop locs
locQuartile = length(locDiffs)/4;            % Compute quartile width

% 2a. Compute periodicity of drops
if(floor(locQuartile)<1)
    hzDrops = 1/(mean(locDiffs)/fps);
else
    hzDrops = 1/(mean(locDiffs(floor(locQuartile):ceil(locQuartile*3)))/fps);
end

% 2b. Display period on screen for input into statistical analysis package
disp( [ 'Drop Kick ~DROP~', fileName, '~', num2str(1/hzDrops, '%.4f'), '~
seconds ~', num2str(hzDrops, '%.4f'), '~ Hz' ] );

% o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o

% 3. Plot drop kinetics
subplot(1,4,1:2);

% 3a. X-axis
t = seconds(1/fps):seconds(1/fps):seconds(L/fps);

% 3b. Compute individual drop frequencies
dropMids = diff(dropLocs)/2;
dropMids = dropMids+dropLocs(1:length(dropMids));
dropMids = seconds(dropMids/fps);
sdDrops = std(1./(diff(dropLocs)/fps));

% 3c. Plot signal with peaks highlighted to show dispensed drops
plot(t, peakSignal, '-o', 'MarkerIndices', dropLocs)
title( 'Drop Kick dS/dt' )
xlabel( 'Time (s)')
ylabel( 'd( \Sigma Intensity )' )
maxY = max(peakSignal);
yl = ylim;
ylim([yl(1), maxY*1.15]);   % Extend y-axis to accomodate sub-title
text( t(ceil(end/2)), maxY*1.1, [' \muDK: ', num2str(hzDrops, '%.4f'), ' Hz
(rsd: ', num2str(sdDrops/hzDrops, '%.3f'), ')'], 'HorizontalAlignment',
'center' );

% 3d. On secondary y-axis, plot drop-kick Hz for each drop
yyaxis right;
eachHz = 1./(diff(dropLocs)/fps);
plot(dropMids, eachHz);
yl = ylim;
ylim([yl(1)*.95, yl(2)*1.1]);
```

```
yl = ylim;
yBump = (yl(2)-yl(1))/10;
for i = 1:length(dropMids)
    h = text( dropMids(i), eachHz(i)+yBump, [num2str(eachHz(i), '%.2f'),
'Hz'], 'HorizontalAlignment', 'center', 'Color', [0.85 0.325 0.098] );
    set( h, 'Rotation', 80);
end
yticklabels([]);    % Mute labels on secondary y-axis to reduce clutter

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% 4. Compute period from Welch's power spectral density
% Use Welch's method (P.D. Welch) to determine spectral density
% ie. power of a signal at different frequencies.
% Algorithm notes: Signal converted from time to Hz domain for
periodogram/spectrum
% Compared to standard periodogram spectrum method and Bartlett's method,
% WSD reduces noise by compromising (reducing) frequency resolution.
% Advantageous when signal contains noise from imperfect or finite data
% where noise reduction is desired.

% 4a. Get spectral density
[wsd, freq] = pwelch(rawSignal,[],[],NFFT,fps);

% 4b. Trim all frequencies above 30 Hz as they are way beoynd our range
i30Hz = find( freq < 30, 1, 'last' );
freq = freq(2:i30Hz);
wsd = wsd(2:i30Hz);

% 4c. Bracket spectrum by ignoring Hz below half the average drop rate
while( freq(1) < hzDrops*0.5 )
    freq = freq(2:length(freq)-1);
    wsd = wsd(2:length(wsd)-1);
end

% 4d. Find peak across entire spectrum
[maxAmp, iMaxAmp] = max(wsd);

% 4e. Attempt to find peak in region derived from drop rate
windowStart = find( freq < hzDrops*0.75, 1, 'last' );
if( isempty(windowStart))
    windowStart = 1;
end;
windowEnd = find( freq > hzDrops*1.25, 1 );
wsdWindow = wsd(windowStart:windowEnd);
[maxAmp, iMaxAmp] = max(wsdWindow);
iMaxAmp = iMaxAmp + windowStart - 1;

% 4f. Compute drop-kick Hz from WSD spectrum
hzWsd = freq(iMaxAmp);

% 4g. Get periodicity from first 3 peaks in WSD spectrum
wsd(~isfinite(wsd)) = 0;
wsdSmooth = smoothLowAmplitude(wsd, 0.25);
[~, wsdLocs]=findpeaks(wsdSmooth);
```

```
wsdHarmonic = median(diff(freq(wsdLocs(1:min([4 length(wsdLocs)])))));

% 4g. Plot spectrum
subplot( 1, 4, 3 );
plot( freq(1:floor(length(freq)/2)), wsd(1:floor(length(freq)/2)), 'k',
'linewidth', 1.2 );
title( 'Welch Spectral Density' )
xlabel('Frequency (Hz)')
ylabel('Spectral Density (Hz^{-1})')
yl = ylim;
maxY = min([yl(2) wsd(iMaxAmp)]);
ylim([yl(1), maxY*1.15]);
text(hzWsd, maxY*1.1, {['\leftarrow DK: ', num2str(hzWsd, '%.4f'), 'Hz'], ['
(H: ', num2str(wsdHarmonic, '%.4f'), 'Hz)']} );
hold on
plot( [hzWsd hzWsd], ylim, ':', 'color', 'black' )
hold off

disp( [ 'Drop Kick ~WSD~', fileName, '~', num2str(1/hzWsd, '%.4f'), '~
seconds ~', num2str(hzWsd, '%.4f'), '~ Hz' ] );

% o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o

% 5. Compute period and harmonics using FFT
% Note: FFT is "conjugate symmetric" so 2-sided spectrum function of both
% positive and negative frequencies [-Fs/2 to +Fs/2).
% Compute 1-sided spectrum (with twice the amplitude) based
% on 2-sided spectrum and signal length L.
% Absolute of complex-valued FFT to get 1-sided magnitude (not phase)

fftAmp = abs(fft(rawSignal,NFFT)/L);        % |FFT Amplitude| 2-sided
fftAmp = 2*fftAmp(1:(NFFT/2)+1);            % 2*|FFT Amplitude| 1-sided
fftHz = (fps/2)*linspace(0,1,(NFFT/2)+1);   % FFT Frequency

% 5a. Trim spectrum as follows:
% Trim all frequencies above 30 Hz as they are way beoynd our range
% Ignore constant offset: fftAmp(1)
fftLen = find( fftHz < 30, 1, 'last' );
fftAmp = fftAmp(2:fftLen);
fftHz = fftHz(2:fftLen);

% 5b. Bracket spectrum by ignoring Hz below half the average drop rate
while( fftHz(1) < hzDrops*0.5 )
    fftLen = length(fftHz)-1;
    fftAmp = fftAmp(2:fftLen);
    fftHz = fftHz(2:fftLen);
end

% 5c. Find peak across entire spectrum
[spectrumPeak, iSpectrumPeak] = max(fftAmp);

% 5d. Attempt to find peak in region derived from drop rate
windowStart = find( fftHz < hzDrops*0.75, 1, 'last' );
windowEnd = find( fftHz > hzDrops*1.25, 1 );
fftWindow = fftAmp(windowStart:windowEnd);
```

```
[maxAmp, iMaxAmp] = max(fftWindow);
iMaxAmp = iMaxAmp + windowStart - 1;

% 5e. Compute drop-kick Hz from FFT spectrum
hzFft = fftHz(iMaxAmp);
hzFftDom = fftHz(iSpectrumPeak);

% 5f. Get periodicity from first 3 peaks in FFT spectrum
fftAmp(~isfinite(fftAmp)) = 0;
fftSmooth = smoothLowAmplitude(fftAmp, 0.25);
[~, fftLocs]=findpeaks(fftSmooth);
fftHarmonic = median(diff(fftHz(fftLocs(1:min([4 length(fftLocs)])))));

% 5g. Plot spectrum
subplot( 1, 4, 4 );
plot( fftHz(1:floor(length(fftHz)/2)), fftAmp(1:floor(length(fftHz)/2)) )
title( 'FFT Spectrum' )
xlabel( 'Frequency (Hz)' )
ylabel( '|Amplitude(db)|' )
yl = ylim;
maxY = min([yl(2) max(fftAmp)]);
ylim([yl(1), maxY*1.15]);
text(hzFft, maxY*1.1, {['\leftarrow DK: ', num2str(hzFft, '%.4f'), 'Hz'], ['
(H: ', num2str(fftHarmonic, '%.4f'), 'Hz)']} );
hold on
plot( [hzFft hzFft], ylim, ':', 'color', 'black' )
hold off

% 5h. Annotate if peak outside range.
if( iSpectrumPeak ~= iMaxAmp )
    disp( [ 'Drop Kick ~FFT~', fileName, '~', num2str(1/hzFft, '%.4f'), '~
seconds ~', num2str(hzFft, '%.4f'), '~ Hz. Dominant harmonic ~',
num2str(hzFftDom), '~ Hz' ] );
else
    disp( [ 'Drop Kick ~FFT~', fileName, '~', num2str(1/hzFft, '%.4f'), '~
seconds ~', num2str(hzFft, '%.4f'), '~ Hz' ] );
end

% o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o

% 6. Save figure to PNG and EPS format files
print( hFigure, [pathName, fileName, '.Analyze.png'], '-dpng', '-r300' );
print( hFigure, [pathName, fileName, '.Analyze.eps'], '-depsc', '-r300' );

% 7. Close figure handle to clean up resources
close(hFigure);

% o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o
```

3. Ansys® Fluent® Runtime Parameters for Water-Air SFT

Version

```
Fluent
Version: axi, pbns, vof, lam, transient (axi, pressure-based, VOF,
laminar, transient)
Release: 18.0.0
Title:
```

Models

Model	Settings
Space	Axisymmetric
Time	Unsteady, 1st-Order Implicit
Viscous	Laminar
Heat Transfer	Disabled
Solidification and Melting	Disabled
Species	Disabled
Coupled Dispersed Phase	Disabled
NOx Pollutants	Disabled
SOx Pollutants	Disabled
Soot	Disabled
Mercury Pollutants	Disabled

Material Properties

Material: water-liquid (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	998.2
Cp (Specific Heat)	j/kg-k	constant	4182
Thermal Conductivity	w/m-k	constant	0.6
Viscosity	kg/m-s	constant	0.001003
Molecular Weight	kg/kmol	constant	18.0152
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Material: air (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1.225
Cp (Specific Heat)	j/kg-k	constant	1006.43
Thermal Conductivity	w/m-k	constant	0.0242
Viscosity	kg/m-s	constant	1.7894e-05
Molecular Weight	kg/kmol	constant	28.966
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Cell Zone Conditions

Zones

name	id	type
fluid_surface1	3	fluid
filled_needle	6	fluid

Setup Conditions

fluid_surface1

Condition	Value
Frame Motion?	no
Mesh Motion?	no

filled_needle

Condition	Value
Frame Motion?	no
Mesh Motion?	no

Boundary Conditions

Zones

name	id	type
symmetry_left_-fluid_surface1	7	symmetry
symmetry_left_-filled_needle	8	symmetry
symmetry_right	9	symmetry
outlet	10	pressure-outlet
inlet	11	velocity-inlet
wall-fluid_surface1	12	wall
wall-filled_needle	14	wall

Setup Conditions

symmetry_left_-fluid_surface1

Condition	Value

symmetry_left_-filled_needle

Condition	Value

symmetry_right

Condition	Value

outlet

Condition	Value

inlet

Condition	Value
Velocity Magnitude (m/s)	0.083

wall-fluid_surface1

Condition	Value
Wall Motion	0
Shear Boundary Condition	0
Contact Angles	(((constant . 0.78539805) (profile)))

wall-filled_needle

Condition	Value
Wall Motion	0
Shear Boundary Condition	0
Contact Angles	(((constant . 0.78539805) (profile)))

Solver Settings

Equations

Equation	Solved
Flow	yes
Volume Fraction	yes
Level-set Function	yes

Numerics

Numeric	Enabled
Absolute Velocity Formulation	yes

Unsteady Calculation Parameters

Time Step (s)	5e-06
Max. Iterations Per Time Step	10

Relaxation

Variable	Relaxation Factor
Pressure	0.3
Density	1
Body Forces	1
Momentum	0.7

```
   Level-set Function   0.3

Linear Solver

                        Solver     Termination   Residual Reduction
   Variable             Type       Criterion     Tolerance
   ------------------------------------------------------------------
   Pressure             V-Cycle    0.1
   X-Momentum           Flexible   0.1           0.7
   Y-Momentum           Flexible   0.1           0.7
   Level-set Function   Flexible   0.1           0.7

Pressure-Velocity Coupling

   Parameter   Value
   ------------------
   Type        SIMPLE

Discretization Scheme

   Variable             Scheme
   ---------------------------------------
   Pressure             PRESTO!
   Momentum             Second Order Upwind
   Volume Fraction      Geo-Reconstruct
   Level-set Function   First Order Upwind

Solution Limits

   Quantity                     Limit
   ---------------------------------
   Minimum Absolute Pressure    1
   Maximum Absolute Pressure    5e+10
   Minimum Temperature          1
   Maximum Temperature          5000
```

4. Ansys® Fluent® Runtime Parameters for Ethanol-Air SFT

Version

```
Fluent
Version: axi, pbns, vof, lam, transient (axi, pressure-based, VOF,
laminar, transient)
Release: 18.0.0
Title:
```

Models

Model	Settings
Space	Axisymmetric
Time	Unsteady, 1st-Order Implicit
Viscous	Laminar
Heat Transfer	Disabled
Solidification and Melting	Disabled
Species	Disabled
Coupled Dispersed Phase	Disabled
NOx Pollutants	Disabled
SOx Pollutants	Disabled
Soot	Disabled
Mercury Pollutants	Disabled

Material Properties

Material: ethyl-alcohol-liquid (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	880
Cp (Specific Heat)	j/kg-k	constant	2470
Thermal Conductivity	w/m-k	constant	0.182
Viscosity	kg/m-s	constant	0.0025
Molecular Weight	kg/kmol	constant	46.07
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Material: air (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1.225
Cp (Specific Heat)	j/kg-k	constant	1006.43
Thermal Conductivity	w/m-k	constant	0.0242
Viscosity	kg/m-s	constant	1.7894e-05
Molecular Weight	kg/kmol	constant	28.966
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Cell Zone Conditions

Zones

name	id	type
fluid_surface1	3	fluid
filled_needle	6	fluid

Setup Conditions

fluid_surface1

Condition	Value
Frame Motion?	no
Mesh Motion?	no

filled_needle

Condition	Value
Frame Motion?	no
Mesh Motion?	no

Boundary Conditions

Zones

name	id	type
symmetry_left_-fluid_surface1	7	symmetry
symmetry_left_-filled_needle	8	symmetry
symmetry_right	9	symmetry
outlet	10	pressure-outlet
inlet	11	velocity-inlet
wall-fluid_surface1	12	wall
wall-filled_needle	14	wall

Setup Conditions

symmetry_left_-fluid_surface1

Condition	Value

symmetry_left_-filled_needle

Condition	Value

symmetry_right

Condition	Value

outlet

```
   Condition   Value
   -----------------
```

inlet

```
   Condition                  Value
   ---------------------------------
   Velocity Magnitude (m/s)   0.0415
```

wall-fluid_surface1

```
   Condition                  Value
   ------------------------------------------------------------------
   Wall Motion                0
   Shear Boundary Condition   0
   Contact Angles             (((constant . 0.78539805) (profile  )))
```

wall-filled_needle

```
   Condition                  Value
   ------------------------------------------------------------------
   Wall Motion                0
   Shear Boundary Condition   0
   Contact Angles             (((constant . 0.78539805) (profile  )))
```

Solver Settings

Equations

```
   Equation             Solved
   --------------------------
   Flow                 yes
   Volume Fraction      yes
   Level-set Function   yes
```

Numerics

```
   Numeric                           Enabled
   ---------------------------------------
   Absolute Velocity Formulation     yes
```

Unsteady Calculation Parameters

```
   ---------------------------------
   Time Step (s)                     1e-06
   Max. Iterations Per Time Step     10
```

Relaxation

```
   Variable             Relaxation Factor
   ---------------------------------------
   Pressure             0.3
   Density              1
   Body Forces          1
```

Momentum	0.7
Level-set Function	0.3

Linear Solver

Variable	Solver Type	Termination Criterion	Residual Reduction Tolerance
Pressure	V-Cycle	0.1	
X-Momentum	Flexible	0.1	0.7
Y-Momentum	Flexible	0.1	0.7
Level-set Function	Flexible	0.1	0.7

Pressure-Velocity Coupling

Parameter	Value
Type	SIMPLE

Discretization Scheme

Variable	Scheme
Pressure	PRESTO!
Momentum	Second Order Upwind
Volume Fraction	Geo-Reconstruct
Level-set Function	First Order Upwind

Solution Limits

Quantity	Limit
Minimum Absolute Pressure	1
Maximum Absolute Pressure	5e+10
Minimum Temperature	1
Maximum Temperature	5000

5. Ansys® Fluent® Runtime Parameters for Chloroform-Air SFT

Version

```
Fluent
Version: axi, pbns, vof, lam, transient (axi, pressure-based, VOF,
laminar, transient)
Release: 18.0.0
Title:
```

Models

Model	Settings
Space	Axisymmetric
Time	Unsteady, 1st-Order Implicit
Viscous	Laminar
Heat Transfer	Disabled
Solidification and Melting	Disabled
Species	Disabled
Coupled Dispersed Phase	Disabled
NOx Pollutants	Disabled
SOx Pollutants	Disabled
Soot	Disabled
Mercury Pollutants	Disabled

Material Properties

Material: chloroform (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1490
Cp (Specific Heat)	j/kg-k	constant	967
Thermal Conductivity	w/m-k	constant	0.129
Viscosity	kg/m-s	constant	0.000563
Molecular Weight	kg/kmol	constant	119.3679
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Material: air (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1.225
Cp (Specific Heat)	j/kg-k	constant	1006.43
Thermal Conductivity	w/m-k	constant	0.0242
Viscosity	kg/m-s	constant	1.7894e-05
Molecular Weight	kg/kmol	constant	28.966
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Cell Zone Conditions

Zones

name	id	type
fluid_surface1	3	fluid
filled_needle	6	fluid

Setup Conditions

fluid_surface1

Condition	Value
Frame Motion?	no
Mesh Motion?	no

filled_needle

Condition	Value
Frame Motion?	no
Mesh Motion?	no

Boundary Conditions

Zones

name	id	type
symmetry_left_-fluid_surface1	7	symmetry
symmetry_left_-filled_needle	8	symmetry
symmetry_right	9	symmetry
outlet	10	pressure-outlet
inlet	11	velocity-inlet
wall-fluid_surface1	12	wall
wall-filled_needle	14	wall

Setup Conditions

symmetry_left_-fluid_surface1

Condition	Value

symmetry_left_-filled_needle

Condition	Value

symmetry_right

Condition	Value

outlet

```
   Condition   Value
   -----------------
```

inlet

```
   Condition                  Value
   ---------------------------------
   Velocity Magnitude (m/s)   0.0415
```

wall-fluid_surface1

```
   Condition                  Value
   ------------------------------------------------------------------
   Wall Motion                0
   Shear Boundary Condition   0
   Contact Angles             (((constant . 0.78539805) (profile  )))
```

wall-filled_needle

```
   Condition                  Value
   ------------------------------------------------------------------
   Wall Motion                0
   Shear Boundary Condition   0
   Contact Angles             (((constant . 0.78539805) (profile  )))
```

Solver Settings

Equations

```
   Equation             Solved
   --------------------------
   Flow                 yes
   Volume Fraction      yes
   Level-set Function   yes
```

Numerics

```
   Numeric                           Enabled
   ---------------------------------------
   Absolute Velocity Formulation     yes
```

Unsteady Calculation Parameters

```
   ------------------------------------
   Time Step (s)                    5e-06
   Max. Iterations Per Time Step    10
```

Relaxation

```
   Variable             Relaxation Factor
   ---------------------------------------
   Pressure             0.3
   Density              1
   Body Forces          1
```

Momentum	0.7
Level-set Function	0.3

Linear Solver

Variable	Solver Type	Termination Criterion	Residual Reduction Tolerance
Pressure	V-Cycle	0.1	
X-Momentum	Flexible	0.1	0.7
Y-Momentum	Flexible	0.1	0.7
Level-set Function	Flexible	0.1	0.7

Pressure-Velocity Coupling

Parameter	Value
Type	SIMPLE

Discretization Scheme

Variable	Scheme
Pressure	PRESTO!
Momentum	Second Order Upwind
Volume Fraction	Geo-Reconstruct
Level-set Function	First Order Upwind

Solution Limits

Quantity	Limit
Minimum Absolute Pressure	1
Maximum Absolute Pressure	5e+10
Minimum Temperature	1
Maximum Temperature	5000

6. Ansys® Fluent® Runtime Parameters for Chloroform-Water IFT

Version

```
Fluent
Version: axi, pbns, vof, lam, transient (axi, pressure-based, VOF,
laminar, transient)
Release: 18.0.0
Title:
```

Models

Model	Settings
Space	Axisymmetric
Time	Unsteady, 1st-Order Implicit
Viscous	Laminar
Heat Transfer	Disabled
Solidification and Melting	Disabled
Species	Disabled
Coupled Dispersed Phase	Disabled
NOx Pollutants	Disabled
SOx Pollutants	Disabled
Soot	Disabled
Mercury Pollutants	Disabled

Material Properties

Material: water-liquid (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	998.2
Cp (Specific Heat)	j/kg-k	constant	4182
Thermal Conductivity	w/m-k	constant	0.6
Viscosity	kg/m-s	constant	0.001003
Molecular Weight	kg/kmol	constant	18.0152
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Material: chloroform (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1490
Cp (Specific Heat)	j/kg-k	constant	967
Thermal Conductivity	w/m-k	constant	0.129
Viscosity	kg/m-s	constant	0.000563
Molecular Weight	kg/kmol	constant	119.3679
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Material: air (fluid)

Property	Units	Method	Value(s)
Density	kg/m3	constant	1.225
Cp (Specific Heat)	j/kg-k	constant	1006.43

Thermal Conductivity	w/m-k	constant	0.0242
Viscosity	kg/m-s	constant	1.7894e-05
Molecular Weight	kg/kmol	constant	28.966
Thermal Expansion Coefficient	1/k	constant	0
Speed of Sound	m/s	none	#f

Cell Zone Conditions

Zones

name	id	type
fluid_surface1	3	fluid
filled_needle	6	fluid

Setup Conditions

fluid_surface1

Condition	Value
Frame Motion?	no
Mesh Motion?	no

filled_needle

Condition	Value
Frame Motion?	no
Mesh Motion?	no

Boundary Conditions

Zones

name	id	type
symmetry_left_-fluid_surface1	7	symmetry
symmetry_left_-filled_needle	8	symmetry
symmetry_right	9	symmetry
outlet	10	pressure-outlet
inlet	11	velocity-inlet
wall-fluid_surface1	12	wall
wall-filled_needle	14	wall

Setup Conditions

symmetry_left_-fluid_surface1

Condition	Value

symmetry_left_-filled_needle

Condition	Value

symmetry_right

Condition	Value

outlet

Condition	Value

inlet

Condition	Value
Velocity Magnitude (m/s)	0.0415

wall-fluid_surface1

Condition	Value
Wall Motion	0
Shear Boundary Condition	0
Contact Angles	(((constant . 0.78539805) (profile)))

wall-filled_needle

Condition	Value
Wall Motion	0
Shear Boundary Condition	0
Contact Angles	(((constant . 0.78539805) (profile)))

Solver Settings

Equations

Equation	Solved
Flow	yes
Volume Fraction	yes
Level-set Function	yes

Numerics

Numeric	Enabled
Absolute Velocity Formulation	yes

Unsteady Calculation Parameters

Time Step (s)	1e-06
Max. Iterations Per Time Step	10

Relaxation

Variable	Relaxation Factor
Pressure	0.3
Density	1
Body Forces	1
Momentum	0.7
Level-set Function	0.3

Linear Solver

Variable	Solver Type	Termination Criterion	Residual Reduction Tolerance
Pressure	V-Cycle	0.1	
X-Momentum	Flexible	0.1	0.7
Y-Momentum	Flexible	0.1	0.7
Level-set Function	Flexible	0.1	0.7

Pressure-Velocity Coupling

Parameter	Value
Type	SIMPLE

Discretization Scheme

Variable	Scheme
Pressure	PRESTO!
Momentum	Second Order Upwind
Volume Fraction	Geo-Reconstruct
Level-set Function	First Order Upwind

Solution Limits

Quantity	Limit
Minimum Absolute Pressure	1
Maximum Absolute Pressure	5e+10
Minimum Temperature	1
Maximum Temperature	5000

7. List of LabVIEW® SubVIs and Express VIs

Low-Level VI (Virtual Instrument) to acquire "drop-kicks" video which is essentially a set of images captures at the specified frame rate from connected CCD camera.


NI_Vision_Acquisition_Software.lvlib:IMAQdx Close Camera.vi


IMAQdx.ctl


NI_Vision_Acquisition_Software.lvlib:IMAQdx Unconfigure Acquisition.vi


subDisplayMessage.vi


IMAQ AVI Close


NI_Vision_Acquisition_Software.lvlib:IMAQdx Stop Acquisition.vi


IMAQ AVI Write Frame


IMAQ AVI Create


subFile Dialog.vi


NI_Vision_Acquisition_Software.lvlib:IMAQdx Get Image.vi


NI_Vision_Acquisition_Software.lvlib:IMAQdx Buffer Number Mode.ctl


NI_Vision_Acquisition_Software.lvlib:IMAQdx Start Acquisition.vi


General Error Handler.vi


DialogType.ctl


IMAQ Create


NI_Vision_Acquisition_Software.lvlib:IMAQdx Configure Acquisition.vi


NI_Vision_Acquisition_Software.lvlib:IMAQdx Acquisition Mode.ctl


NI_Vision_Acquisition_Software.lvlib:IMAQdx Open Camera.vi

VI Revision History
"DalsaControl3.0.DropKicks.vi History"
Current Revision: 216

8. Frequencies for SFT/IFT from CFD Solution

Material	Q (mL/min)	γ (dyne/cm)	hzDrop	hzWsd	hzFft	hzMean	hzSd
70etOH-Air	5	24	5.4289	5.3978	5.3978	5.4082	0.3%
70etOH-Air	5	25	5.1020	5.0888	5.0850	5.0919	0.2%
70etOH-Air	5	26	5.0505	5.0392	5.0392	5.0430	0.1%
70etOH-Air	5	27	4.8077	4.8027	4.7989	4.8031	0.1%
70etOH-Air	5	28	4.6339	4.6158	4.6082	4.6193	0.3%
70etOH-Air	5	29	4.4297	4.4441	4.4174	4.4304	0.3%
70etOH-Air	5	30	4.4170	4.4136	4.4136	4.4147	0.0%
Water-Air	5	40	3.7783	3.7479	3.7479	3.7581	0.5%
Water-Air	5	42	3.6810	3.6564	3.6697	3.6690	0.3%
Water-Air	5	45	3.4412	3.4161	3.4180	3.4251	0.4%
Water-Air	5	47	3.3311	3.3131	3.3131	3.3191	0.3%
Water-Air	5	50	3.1070	3.1223	3.1109	3.1134	0.3%
Water-Air	5	52	3.0659	3.0212	3.0136	3.0336	0.9%
Water-Air	5	55	2.9795	2.9411	2.9354	2.9520	0.8%
Water-Air	5	57	2.8289	2.7885	2.7714	2.7963	1.1%
Water-Air	5	62	2.6178	2.6112	2.5806	2.6032	0.8%
Water-Air	5	65	2.5641	2.5387	2.5311	2.5446	0.7%
Water-Air	5	67	2.5291	2.4910	2.5139	2.5113	0.8%
Water-Air	5	70	2.4450	2.4338	2.4319	2.4369	0.3%
Water-Air	5	71.5	2.3627	2.3441	2.3270	2.3446	0.8%
Water-Air	5	72	2.2379	2.2087	2.2163	2.2210	0.7%
Water-Air	5	72.5	2.2379	2.2087	2.2163	2.2210	0.7%
Water-Air	5	75	2.1708	2.2106	2.1362	2.1725	1.7%
ChCl3-Air	3	24	5.4306	5.4302	5.4264	5.4291	0.0%
ChCl3-Air	3	25	5.2711	5.2605	5.2567	5.2627	0.1%
ChCl3-Air	3	26	5.1238	5.1041	5.1041	5.1107	0.2%
ChCl3-Air	3	27	4.8980	4.8828	4.8828	4.8879	0.2%
ChCl3-Air	3	28	4.7244	4.7188	4.7188	4.7207	0.1%
ChCl3-Air	3	29	4.6125	4.5891	4.5891	4.5969	0.3%
ChCl3-Water	5	28	2.4651	2.3842	2.4643	2.4379	1.9%
ChCl3-Water	5	29	2.3943	2.3270	2.3880	2.3697	1.6%
ChCl3-Water	5	30	2.3274	2.2087	2.3270	2.2877	3.0%
ChCl3-Water	5	31	2.2624	2.1362	2.2659	2.2215	3.3%
ChCl3-Water	5	32	2.2010	2.0561	2.2011	2.1527	3.9%
ChCl3-Water	5	33	2.1398	2.0256	2.1400	2.1018	3.1%

9. Interpolated Adjusted CFD Frequencies for Water-Air SFT @ 5 mL/minute

γ (dyne/cm)	hzAdj
40.00	3.5980
40.05	3.5970
40.10	3.5959
40.15	3.5947
40.20	3.5935
40.25	3.5923
40.30	3.5910
40.35	3.5896
40.40	3.5882
40.45	3.5868
40.50	3.5853
40.55	3.5837
40.60	3.5821
40.65	3.5805
40.70	3.5788
40.75	3.5771
40.80	3.5753
40.85	3.5735
40.90	3.5717
40.95	3.5698
41.00	3.5679
41.05	3.5659
41.10	3.5640
41.15	3.5619
41.20	3.5599
41.25	3.5578
41.30	3.5557
41.35	3.5535
41.40	3.5513
41.45	3.5491
41.50	3.5468
41.55	3.5446
41.60	3.5423
41.65	3.5399
41.70	3.5376
41.75	3.5352
41.80	3.5328
41.85	3.5304

γ (dyne/cm)	hzAdj
41.90	3.5279
41.95	3.5254
42.00	3.5229
42.05	3.5204
42.10	3.5177
42.15	3.5149
42.20	3.5119
42.25	3.5089
42.30	3.5057
42.35	3.5024
42.40	3.4990
42.45	3.4955
42.50	3.4919
42.55	3.4882
42.60	3.4845
42.65	3.4806
42.70	3.4767
42.75	3.4727
42.80	3.4686
42.85	3.4644
42.90	3.4602
42.95	3.4560
43.00	3.4516
43.05	3.4472
43.10	3.4428
43.15	3.4384
43.20	3.4338
43.25	3.4293
43.30	3.4247
43.35	3.4201
43.40	3.4155
43.45	3.4109
43.50	3.4062
43.55	3.4016
43.60	3.3969
43.65	3.3923
43.70	3.3876
43.75	3.3829

γ (dyne/cm)	hzAdj
43.80	3.3783
43.85	3.3737
43.90	3.3691
43.95	3.3645
44.00	3.3599
44.05	3.3554
44.10	3.3509
44.15	3.3465
44.20	3.3421
44.25	3.3377
44.30	3.3334
44.35	3.3292
44.40	3.3250
44.45	3.3209
44.50	3.3169
44.55	3.3129
44.60	3.3090
44.65	3.3052
44.70	3.3015
44.75	3.2979
44.80	3.2943
44.85	3.2909
44.90	3.2876
44.95	3.2844
45.00	3.2813
45.05	3.2782
45.10	3.2753
45.15	3.2724
45.20	3.2696
45.25	3.2668
45.30	3.2641
45.35	3.2614
45.40	3.2587
45.45	3.2562
45.50	3.2536
45.55	3.2511
45.60	3.2486
45.65	3.2462

γ (dyne/cm)	hzAdj
45.70	3.2438
45.75	3.2414
45.80	3.2390
45.85	3.2367
45.90	3.2343
45.95	3.2320
46.00	3.2297
46.05	3.2274
46.10	3.2251
46.15	3.2228
46.20	3.2204
46.25	3.2181
46.30	3.2158
46.35	3.2135
46.40	3.2111
46.45	3.2087
46.50	3.2064
46.55	3.2039
46.60	3.2015
46.65	3.1990
46.70	3.1965
46.75	3.1940
46.80	3.1914
46.85	3.1887
46.90	3.1861
46.95	3.1833
47.00	3.1805
47.05	3.1777
47.10	3.1748
47.15	3.1719
47.20	3.1690
47.25	3.1659
47.30	3.1629
47.35	3.1598
47.40	3.1567
47.45	3.1536
47.50	3.1504
47.55	3.1472

γ (dyne/cm)	hzAdj
47.60	3.1439
47.65	3.1407
47.70	3.1374
47.75	3.1341
47.80	3.1307
47.85	3.1274
47.90	3.1240
47.95	3.1206
48.00	3.1172
48.05	3.1138
48.10	3.1103
48.15	3.1069
48.20	3.1034
48.25	3.0999
48.30	3.0965
48.35	3.0930
48.40	3.0895
48.45	3.0860
48.50	3.0826
48.55	3.0791
48.60	3.0756
48.65	3.0721
48.70	3.0687
48.75	3.0652
48.80	3.0618
48.85	3.0583
48.90	3.0549
48.95	3.0515
49.00	3.0481
49.05	3.0448
49.10	3.0414
49.15	3.0381
49.20	3.0348
49.25	3.0315
49.30	3.0283
49.35	3.0250
49.40	3.0218
49.45	3.0187
49.50	3.0156

γ (dyne/cm)	hzAdj
49.55	3.0125
49.60	3.0094
49.65	3.0064
49.70	3.0034
49.75	3.0005
49.80	2.9976
49.85	2.9947
49.90	2.9919
49.95	2.9892
50.00	2.9865
50.05	2.9838
50.10	2.9811
50.15	2.9784
50.20	2.9757
50.25	2.9731
50.30	2.9704
50.35	2.9678
50.40	2.9651
50.45	2.9625
50.50	2.9599
50.55	2.9573
50.60	2.9547
50.65	2.9521
50.70	2.9496
50.75	2.9470
50.80	2.9445
50.85	2.9420
50.90	2.9395
50.95	2.9371
51.00	2.9347
51.05	2.9323
51.10	2.9299
51.15	2.9275
51.20	2.9252
51.25	2.9229
51.30	2.9207
51.35	2.9184
51.40	2.9163
51.45	2.9141

γ (dyne/cm)	hzAdj
51.50	2.9120
51.55	2.9099
51.60	2.9079
51.65	2.9059
51.70	2.9039
51.75	2.9020
51.80	2.9001
51.85	2.8983
51.90	2.8965
51.95	2.8948
52.00	2.8931
52.05	2.8914
52.10	2.8898
52.15	2.8883
52.20	2.8868
52.25	2.8854
52.30	2.8839
52.35	2.8826
52.40	2.8812
52.45	2.8800
52.50	2.8787
52.55	2.8775
52.60	2.8763
52.65	2.8751
52.70	2.8740
52.75	2.8728
52.80	2.8717
52.85	2.8707
52.90	2.8696
52.95	2.8686
53.00	2.8676
53.05	2.8666
53.10	2.8656
53.15	2.8646
53.20	2.8636
53.25	2.8626
53.30	2.8617
53.35	2.8607
53.40	2.8597

γ (dyne/cm)	hzAdj
53.45	2.8588
53.50	2.8578
53.55	2.8568
53.60	2.8559
53.65	2.8549
53.70	2.8539
53.75	2.8529
53.80	2.8518
53.85	2.8508
53.90	2.8497
53.95	2.8487
54.00	2.8475
54.05	2.8464
54.10	2.8453
54.15	2.8441
54.20	2.8429
54.25	2.8416
54.30	2.8404
54.35	2.8391
54.40	2.8377
54.45	2.8363
54.50	2.8349
54.55	2.8334
54.60	2.8319
54.65	2.8304
54.70	2.8288
54.75	2.8271
54.80	2.8254
54.85	2.8236
54.90	2.8218
54.95	2.8199
55.00	2.8180
55.05	2.8159
55.10	2.8136
55.15	2.8110
55.20	2.8082
55.25	2.8051
55.30	2.8019
55.35	2.7985

γ (dyne/cm)	hzAdj
55.40	2.7949
55.45	2.7912
55.50	2.7873
55.55	2.7832
55.60	2.7791
55.65	2.7748
55.70	2.7704
55.75	2.7659
55.80	2.7614
55.85	2.7567
55.90	2.7521
55.95	2.7474
56.00	2.7426
56.05	2.7378
56.10	2.7331
56.15	2.7283
56.20	2.7236
56.25	2.7189
56.30	2.7142
56.35	2.7096
56.40	2.7051
56.45	2.7006
56.50	2.6963
56.55	2.6920
56.60	2.6879
56.65	2.6839
56.70	2.6800
56.75	2.6763
56.80	2.6728
56.85	2.6694
56.90	2.6662
56.95	2.6633
57.00	2.6605
57.05	2.6579
57.10	2.6553
57.15	2.6527
57.20	2.6501
57.25	2.6475
57.30	2.6450

γ (dyne/cm)	hzAdj
57.35	2.6425
57.40	2.6400
57.45	2.6375
57.50	2.6350
57.55	2.6325
57.60	2.6301
57.65	2.6277
57.70	2.6253
57.75	2.6229
57.80	2.6205
57.85	2.6181
57.90	2.6158
57.95	2.6135
58.00	2.6112
58.05	2.6089
58.10	2.6066
58.15	2.6043
58.20	2.6021
58.25	2.5999
58.30	2.5976
58.35	2.5954
58.40	2.5933
58.45	2.5911
58.50	2.5890
58.55	2.5868
58.60	2.5847
58.65	2.5826
58.70	2.5805
58.75	2.5785
58.80	2.5764
58.85	2.5744
58.90	2.5724
58.95	2.5704
59.00	2.5684
59.05	2.5664
59.10	2.5645
59.15	2.5625
59.20	2.5606
59.25	2.5587

γ (dyne/cm)	hzAdj
59.30	2.5568
59.35	2.5549
59.40	2.5531
59.45	2.5512
59.50	2.5494
59.55	2.5476
59.60	2.5458
59.65	2.5440
59.70	2.5423
59.75	2.5405
59.80	2.5388
59.85	2.5371
59.90	2.5353
59.95	2.5337
60.00	2.5320
60.05	2.5303
60.10	2.5287
60.15	2.5271
60.20	2.5255
60.25	2.5239
60.30	2.5223
60.35	2.5207
60.40	2.5192
60.45	2.5176
60.50	2.5161
60.55	2.5146
60.60	2.5131
60.65	2.5116
60.70	2.5102
60.75	2.5087
60.80	2.5073
60.85	2.5059
60.90	2.5045
60.95	2.5031
61.00	2.5017
61.05	2.5004
61.10	2.4990
61.15	2.4977
61.20	2.4964

γ (dyne/cm)	hzAdj
61.25	2.4951
61.30	2.4938
61.35	2.4926
61.40	2.4913
61.45	2.4901
61.50	2.4889
61.55	2.4876
61.60	2.4865
61.65	2.4853
61.70	2.4841
61.75	2.4830
61.80	2.4818
61.85	2.4807
61.90	2.4796
61.95	2.4785
62.00	2.4774
62.05	2.4764
62.10	2.4753
62.15	2.4742
62.20	2.4732
62.25	2.4722
62.30	2.4712
62.35	2.4702
62.40	2.4692
62.45	2.4682
62.50	2.4672
62.55	2.4662
62.60	2.4653
62.65	2.4643
62.70	2.4634
62.75	2.4624
62.80	2.4615
62.85	2.4606
62.90	2.4597
62.95	2.4588
63.00	2.4579
63.05	2.4570
63.10	2.4562
63.15	2.4553

γ (dyne/cm)	hzAdj
63.20	2.4545
63.25	2.4536
63.30	2.4528
63.35	2.4520
63.40	2.4512
63.45	2.4504
63.50	2.4496
63.55	2.4488
63.60	2.4480
63.65	2.4472
63.70	2.4465
63.75	2.4457
63.80	2.4450
63.85	2.4443
63.90	2.4435
63.95	2.4428
64.00	2.4421
64.05	2.4414
64.10	2.4407
64.15	2.4400
64.20	2.4394
64.25	2.4387
64.30	2.4381
64.35	2.4374
64.40	2.4368
64.45	2.4362
64.50	2.4355
64.55	2.4349
64.60	2.4343
64.65	2.4337
64.70	2.4331
64.75	2.4326
64.80	2.4320
64.85	2.4314
64.90	2.4309
64.95	2.4303
65.00	2.4298
65.05	2.4293
65.10	2.4288

γ (dyne/cm)	hzAdj
65.15	2.4283
65.20	2.4278
65.25	2.4274
65.30	2.4270
65.35	2.4266
65.40	2.4262
65.45	2.4258
65.50	2.4254
65.55	2.4250
65.60	2.4247
65.65	2.4243
65.70	2.4240
65.75	2.4236
65.80	2.4233
65.85	2.4229
65.90	2.4226
65.95	2.4223
66.00	2.4219
66.05	2.4216
66.10	2.4213
66.15	2.4209
66.20	2.4206
66.25	2.4202
66.30	2.4199
66.35	2.4195
66.40	2.4191
66.45	2.4187
66.50	2.4183
66.55	2.4179
66.60	2.4175
66.65	2.4170
66.70	2.4166
66.75	2.4161
66.80	2.4156
66.85	2.4150
66.90	2.4145
66.95	2.4139
67.00	2.4133
67.05	2.4127

γ (dyne/cm)	hzAdj
67.10	2.4121
67.15	2.4114
67.20	2.4107
67.25	2.4100
67.30	2.4093
67.35	2.4085
67.40	2.4077
67.45	2.4069
67.50	2.4060
67.55	2.4052
67.60	2.4043
67.65	2.4034
67.70	2.4025
67.75	2.4015
67.80	2.4005
67.85	2.3995
67.90	2.3985
67.95	2.3974
68.00	2.3963
68.05	2.3952
68.10	2.3941
68.15	2.3930
68.20	2.3918
68.25	2.3906
68.30	2.3894
68.35	2.3882
68.40	2.3869
68.45	2.3856
68.50	2.3843
68.55	2.3830
68.60	2.3816
68.65	2.3802
68.70	2.3788
68.75	2.3774
68.80	2.3760
68.85	2.3745
68.90	2.3730
68.95	2.3715
69.00	2.3699

γ (dyne/cm)	hzAdj
69.05	2.3684
69.10	2.3668
69.15	2.3652
69.20	2.3636
69.25	2.3619
69.30	2.3603
69.35	2.3586
69.40	2.3569
69.45	2.3551
69.50	2.3534
69.55	2.3516
69.60	2.3498
69.65	2.3480
69.70	2.3461
69.75	2.3442
69.80	2.3424
69.85	2.3404
69.90	2.3385
69.95	2.3366
70.00	2.3346
70.05	2.3325
70.10	2.3303
70.15	2.3279
70.20	2.3253
70.25	2.3226
70.30	2.3197
70.35	2.3167
70.40	2.3136
70.45	2.3104
70.50	2.3071
70.55	2.3037
70.60	2.3002
70.65	2.2966
70.70	2.2930
70.75	2.2893
70.80	2.2856
70.85	2.2818
70.90	2.2780
70.95	2.2742

γ (dyne/cm)	hzAdj
71.00	2.2704
71.05	2.2666
71.10	2.2628
71.15	2.2590
71.20	2.2553
71.25	2.2516
71.30	2.2479
71.35	2.2443
71.40	2.2407
71.45	2.2373
71.50	2.2339
71.55	2.2307
71.60	2.2278
71.65	2.2251
71.70	2.2226
71.75	2.2202
71.80	2.2178
71.85	2.2153
71.90	2.2127
71.95	2.2100
72.00	2.2070

γ (dyne/cm)	hzAdj
72.05	2.2038
72.10	2.2002
72.15	2.1961
72.20	2.1916
72.25	2.1865
72.30	2.1808
72.35	2.1708
72.40	2.1556
72.45	2.1398
72.50	2.1277
72.55	2.1190
72.60	2.1107
72.65	2.1033
72.70	2.0970
72.75	2.0922
72.80	2.0892
72.85	2.0874
72.90	2.0855
72.95	2.0838
73.00	2.0820
73.05	2.0804

γ (dyne/cm)	hzAdj
73.10	2.0788
73.15	2.0772
73.20	2.0757
73.25	2.0742
73.30	2.0728
73.35	2.0714
73.40	2.0701
73.45	2.0689
73.50	2.0676
73.55	2.0665
73.60	2.0653
73.65	2.0643
73.70	2.0632
73.75	2.0622
73.80	2.0613
73.85	2.0604
73.90	2.0595
73.95	2.0587
74.00	2.0579
74.05	2.0572
74.10	2.0565

γ (dyne/cm)	hzAdj
74.15	2.0559
74.20	2.0553
74.25	2.0547
74.30	2.0542
74.35	2.0537
74.40	2.0533
74.45	2.0529
74.50	2.0525
74.55	2.0522
74.60	2.0519
74.65	2.0516
74.70	2.0514
74.75	2.0512
74.80	2.0510
74.85	2.0509
74.90	2.0508
74.95	2.0508
75.00	2.0508

10. Interpolated Adjusted CFD Frequencies for 70% Ethanol-Air SFT @ 5 mL/minute

γ (dyne/cm)	hzAdj
24.00	5.4788
24.05	5.4562
24.10	5.4339
24.15	5.4119
24.20	5.3904
24.25	5.3692
24.30	5.3487
24.35	5.3288
24.40	5.3096
24.45	5.2911
24.50	5.2735
24.55	5.2569
24.60	5.2412
24.65	5.2266
24.70	5.2132
24.75	5.2010
24.80	5.1902
24.85	5.1807
24.90	5.1726
24.95	5.1662
25.00	5.1613
25.05	5.1575
25.10	5.1541
25.15	5.1512
25.20	5.1486
25.25	5.1463
25.30	5.1442
25.35	5.1424
25.40	5.1407
25.45	5.1392
25.50	5.1377

γ (dyne/cm)	hzAdj
25.55	5.1362
25.60	5.1346
25.65	5.1330
25.70	5.1312
25.75	5.1292
25.80	5.1270
25.85	5.1245
25.90	5.1217
25.95	5.1185
26.00	5.1148
26.05	5.1100
26.10	5.1036
26.15	5.0957
26.20	5.0864
26.25	5.0758
26.30	5.0642
26.35	5.0517
26.40	5.0384
26.45	5.0245
26.50	5.0101
26.55	4.9953
26.60	4.9803
26.65	4.9653
26.70	4.9504
26.75	4.9357
26.80	4.9214
26.85	4.9076
26.90	4.8945
26.95	4.8822
27.00	4.8709
27.05	4.8602

γ (dyne/cm)	hzAdj
27.10	4.8497
27.15	4.8394
27.20	4.8293
27.25	4.8193
27.30	4.8095
27.35	4.7998
27.40	4.7902
27.45	4.7807
27.50	4.7713
27.55	4.7619
27.60	4.7526
27.65	4.7433
27.70	4.7340
27.75	4.7246
27.80	4.7153
27.85	4.7059
27.90	4.6964
27.95	4.6869
28.00	4.6773
28.05	4.6672
28.10	4.6562
28.15	4.6447
28.20	4.6326
28.25	4.6202
28.30	4.6075
28.35	4.5947
28.40	4.5820
28.45	4.5694
28.50	4.5572
28.55	4.5455
28.60	4.5343

γ (dyne/cm)	hzAdj
28.65	4.5239
28.70	4.5144
28.75	4.5059
28.80	4.4986
28.85	4.4926
28.90	4.4880
28.95	4.4850
29.00	4.4837
29.05	4.4833
29.10	4.4830
29.15	4.4826
29.20	4.4823
29.25	4.4820
29.30	4.4817
29.35	4.4815
29.40	4.4812
29.45	4.4810
29.50	4.4808
29.55	4.4806
29.60	4.4804
29.65	4.4803
29.70	4.4802
29.75	4.4801
29.80	4.4800
29.85	4.4799
29.90	4.4798
29.95	4.4798
30.00	4.4798

11. Interpolated Adjusted CFD Frequencies for Chloroform-Air SFT @ 3 mL/minute

γ (dyne/cm)	hzAdj
24.00	5.5078
24.05	5.4988
24.10	5.4898
24.15	5.4808
24.20	5.4719
24.25	5.4631
24.30	5.4543
24.35	5.4455
24.40	5.4367
24.45	5.4281
24.50	5.4194
24.55	5.4108
24.60	5.4023
24.65	5.3938
24.70	5.3853
24.75	5.3769
24.80	5.3685
24.85	5.3602
24.90	5.3519
24.95	5.3437
25.00	5.3355
25.05	5.3275
25.10	5.3196
25.15	5.3119
25.20	5.3044
25.25	5.2970

γ (dyne/cm)	hzAdj
25.30	5.2896
25.35	5.2823
25.40	5.2751
25.45	5.2679
25.50	5.2606
25.55	5.2533
25.60	5.2459
25.65	5.2384
25.70	5.2308
25.75	5.2230
25.80	5.2150
25.85	5.2068
25.90	5.1983
25.95	5.1896
26.00	5.1806
26.05	5.1712
26.10	5.1612
26.15	5.1508
26.20	5.1399
26.25	5.1287
26.30	5.1172
26.35	5.1055
26.40	5.0935
26.45	5.0815
26.50	5.0693
26.55	5.0572

γ (dyne/cm)	hzAdj
26.60	5.0450
26.65	5.0330
26.70	5.0211
26.75	5.0094
26.80	4.9980
26.85	4.9869
26.90	4.9762
26.95	4.9659
27.00	4.9561
27.05	4.9466
27.10	4.9372
27.15	4.9280
27.20	4.9190
27.25	4.9100
27.30	4.9012
27.35	4.8926
27.40	4.8840
27.45	4.8756
27.50	4.8673
27.55	4.8591
27.60	4.8510
27.65	4.8430
27.70	4.8351
27.75	4.8273
27.80	4.8196
27.85	4.8120

γ (dyne/cm)	hzAdj
27.90	4.8044
27.95	4.7969
28.00	4.7896
28.05	4.7822
28.10	4.7750
28.15	4.7678
28.20	4.7607
28.25	4.7537
28.30	4.7467
28.35	4.7398
28.40	4.7330
28.45	4.7263
28.50	4.7196
28.55	4.7131
28.60	4.7066
28.65	4.7002
28.70	4.6939
28.75	4.6877
28.80	4.6815
28.85	4.6755
28.90	4.6695
28.95	4.6637
29.00	4.6579

12. Interpolated Adjusted CFD Frequencies for Chloroform-Water IFT @ 5 mL/minute

γ (dyne/cm)	hzAdj
28.00	2.5013
28.05	2.4970
28.10	2.4928
28.15	2.4886
28.20	2.4845
28.25	2.4804
28.30	2.4763
28.35	2.4723
28.40	2.4683
28.45	2.4644
28.50	2.4605
28.55	2.4566
28.60	2.4528
28.65	2.4490
28.70	2.4453
28.75	2.4416
28.80	2.4380
28.85	2.4344
28.90	2.4308
28.95	2.4273
29.00	2.4238
29.05	2.4204
29.10	2.4171
29.15	2.4138
29.20	2.4105
29.25	2.4074

γ (dyne/cm)	hzAdj
29.30	2.4042
29.35	2.4011
29.40	2.3980
29.45	2.3950
29.50	2.3920
29.55	2.3890
29.60	2.3860
29.65	2.3830
29.70	2.3800
29.75	2.3770
29.80	2.3740
29.85	2.3710
29.90	2.3680
29.95	2.3650
30.00	2.3619
30.05	2.3588
30.10	2.3557
30.15	2.3526
30.20	2.3495
30.25	2.3465
30.30	2.3434
30.35	2.3403
30.40	2.3373
30.45	2.3342
30.50	2.3311
30.55	2.3281

γ (dyne/cm)	hzAdj
30.60	2.3250
30.65	2.3219
30.70	2.3188
30.75	2.3157
30.80	2.3125
30.85	2.3094
30.90	2.3063
30.95	2.3031
31.00	2.2999
31.05	2.2967
31.10	2.2935
31.15	2.2902
31.20	2.2869
31.25	2.2837
31.30	2.2803
31.35	2.2770
31.40	2.2737
31.45	2.2703
31.50	2.2670
31.55	2.2637
31.60	2.2603
31.65	2.2570
31.70	2.2537
31.75	2.2504
31.80	2.2471
31.85	2.2438

γ (dyne/cm)	hzAdj
31.90	2.2405
31.95	2.2373
32.00	2.2341
32.05	2.2309
32.10	2.2277
32.15	2.2246
32.20	2.2214
32.25	2.2183
32.30	2.2151
32.35	2.2120
32.40	2.2089
32.45	2.2057
32.50	2.2026
32.55	2.1996
32.60	2.1965
32.65	2.1934
32.70	2.1903
32.75	2.1873
32.80	2.1842
32.85	2.1812
32.90	2.1782
32.95	2.1752
33.00	2.1721