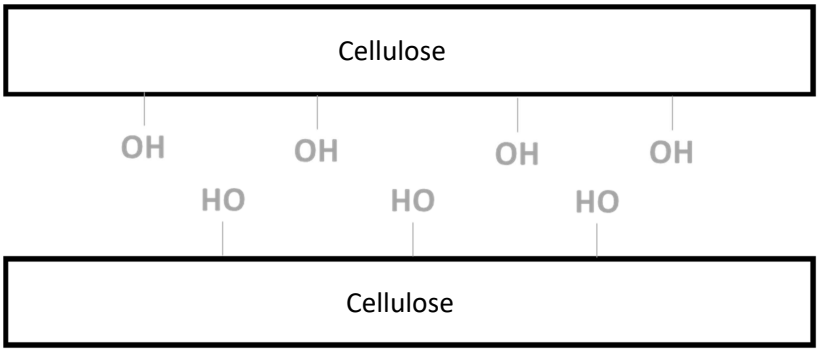
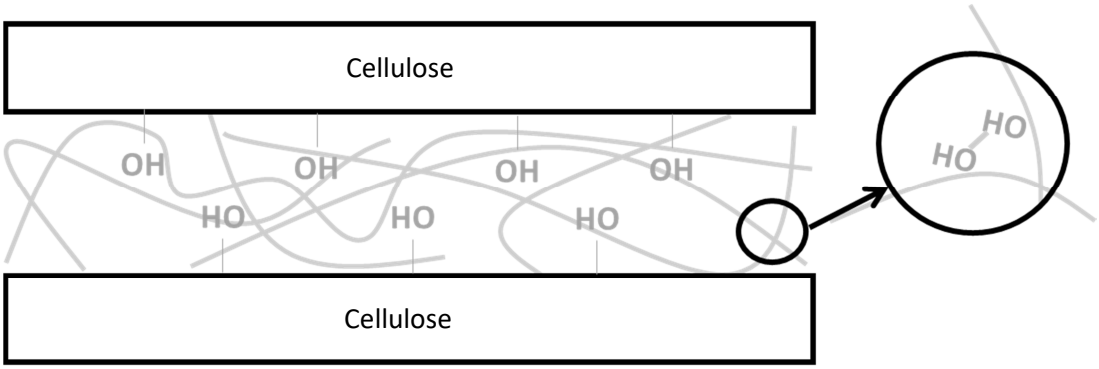
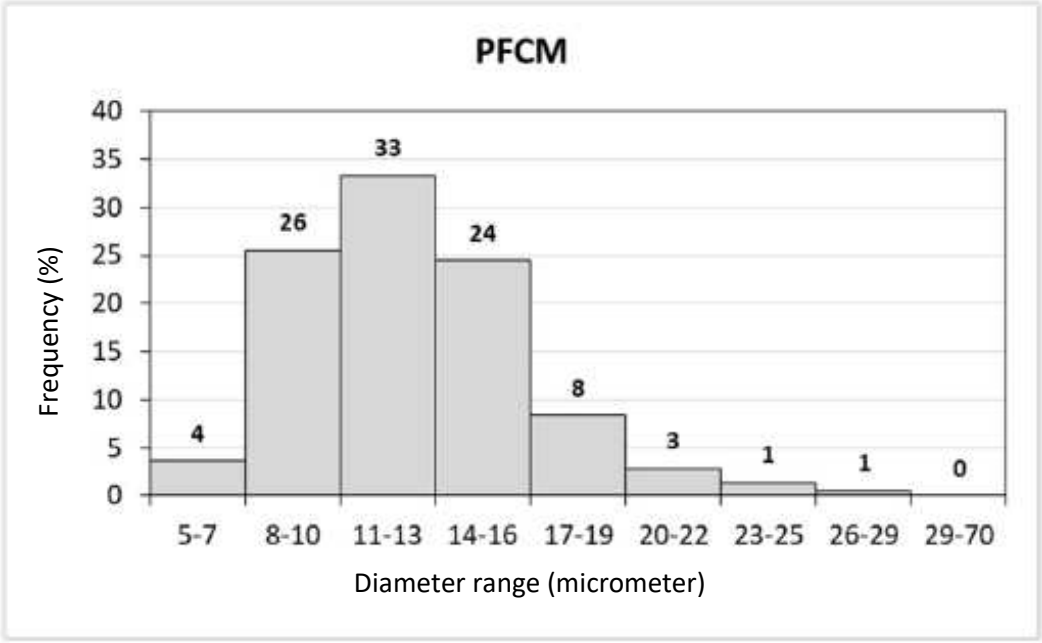


Case A - Medium without application of microfibrillated cellulose (MFC) in pulp

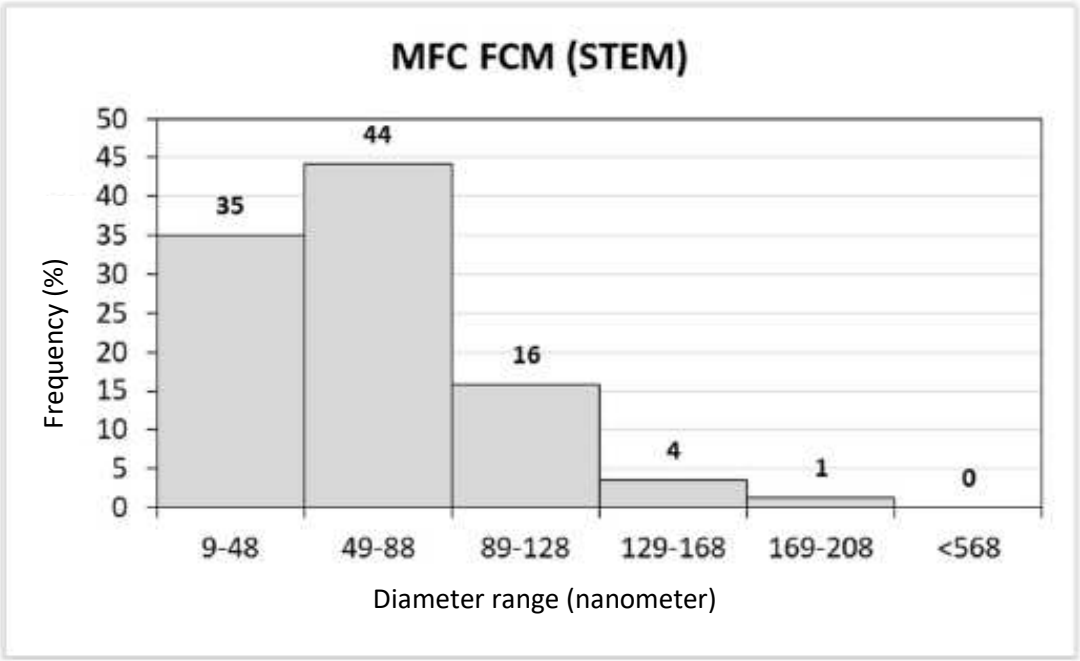


Case B - Medium with application of microfibrillated cellulose (MFC) in pulp

Figure 1

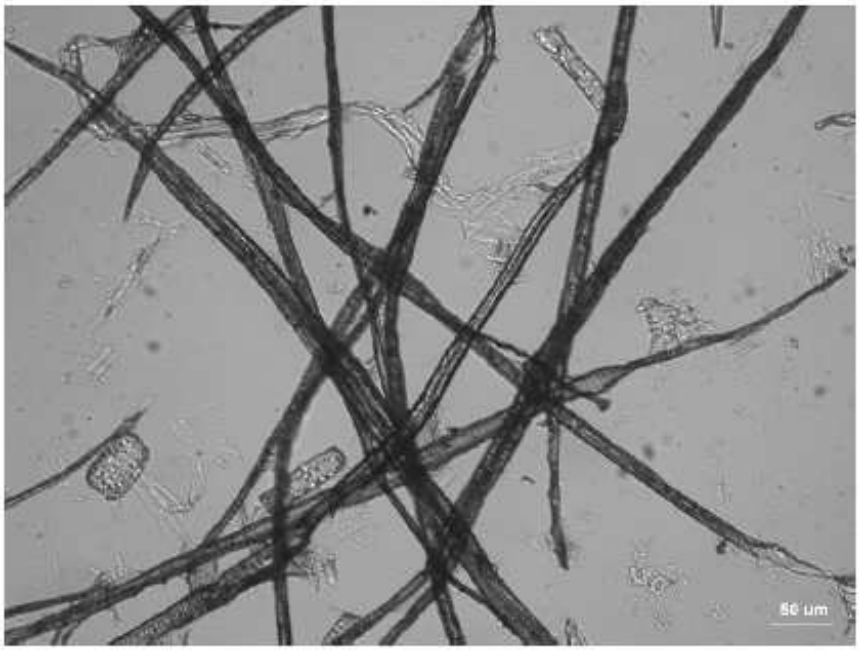

PFCM
Frequency (%)
40
35
30
25
20
15
10
5
0
4
26
33
24
8
3
1
1
0
5-7
8-10
11-13
14-16
17-19
20-22
23-25
26-29
29-70
Diameter range (micrometer)

(A)

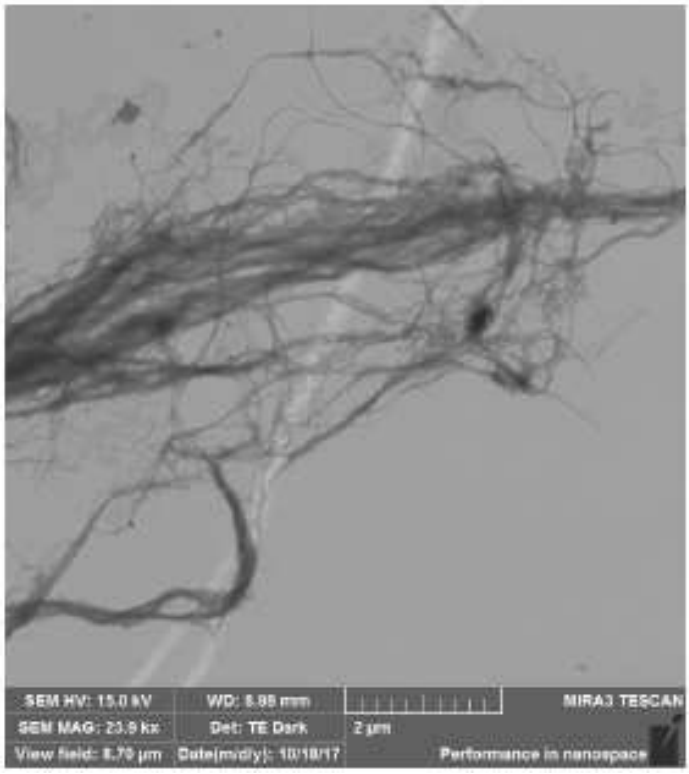

MFC FCM (STEM)
Frequency (%)
50
45
40
35
30
25
20
15
10
5
0
35
44
16
4
1
0
9-48
49-88
89-128
129-168
169-208
<568
Diameter range (nanometer)

(B)

Figure 2

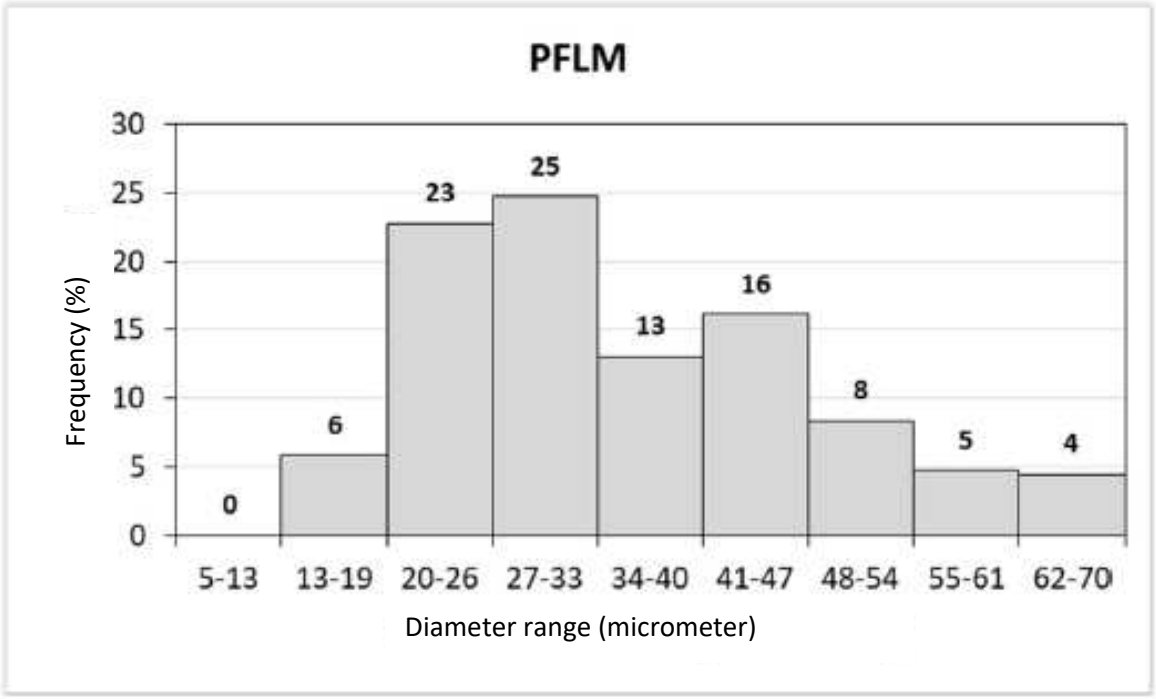

50 µm

(A)

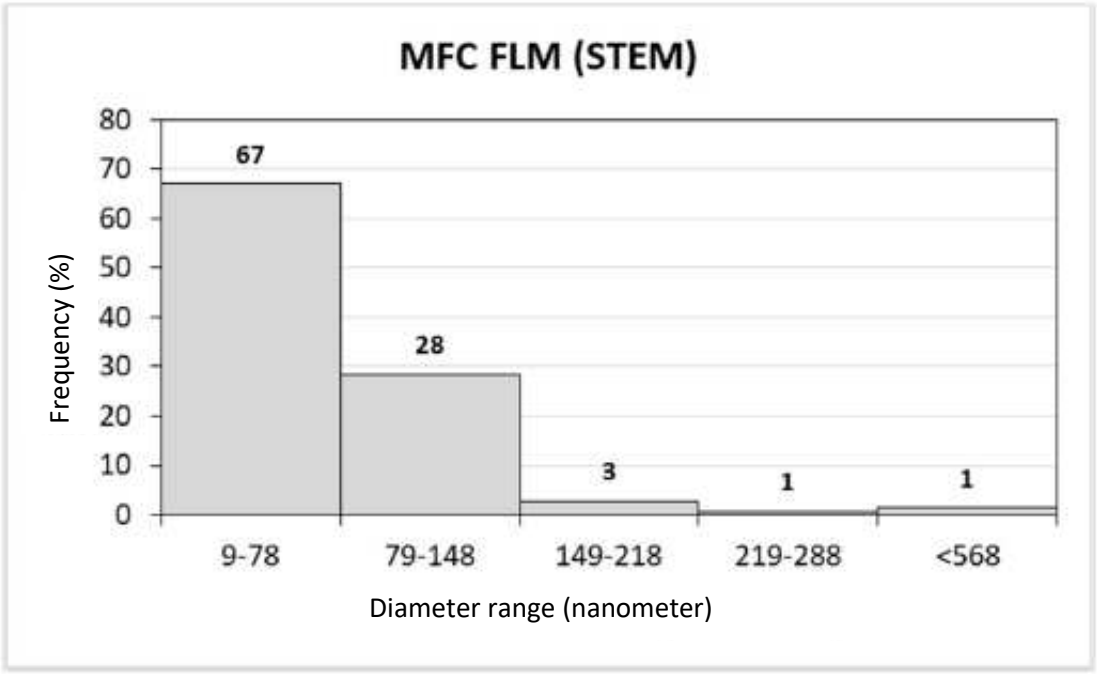

SEM HV: 15.0 kV
WD: 8.98 mm
MIRA3 TESCAN
SEM MAG: 23.9 kx
Det: TE Dark
2 µm
View field: 8.79 µm
Date(m/d/y): 10/18/17
Performance in nanospace

(B)

Figure 3

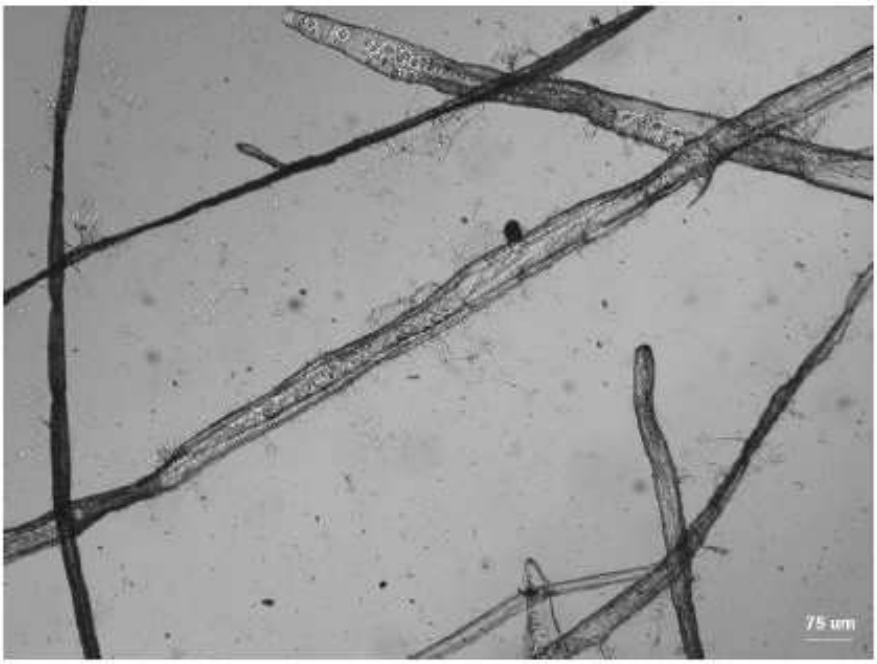

PFLM
Frequency (%)
30
25
20
15
10
5
0
0
6
23
25
13
16
8
5
4
5-13
13-19
20-26
27-33
34-40
41-47
48-54
55-61
62-70
Diameter range (micrometer)

(A)

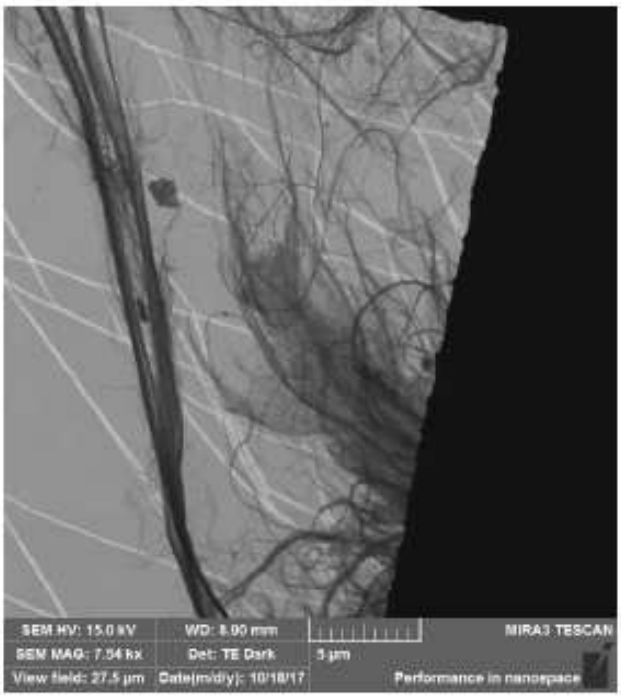

MFC FLM (STEM)
Frequency (%)
80
70
60
50
40
30
20
10
0
67
28
3
1
1
9-78
79-148
149-218
219-288
<568
Diameter range (nanometer)

(B)

Figure 4

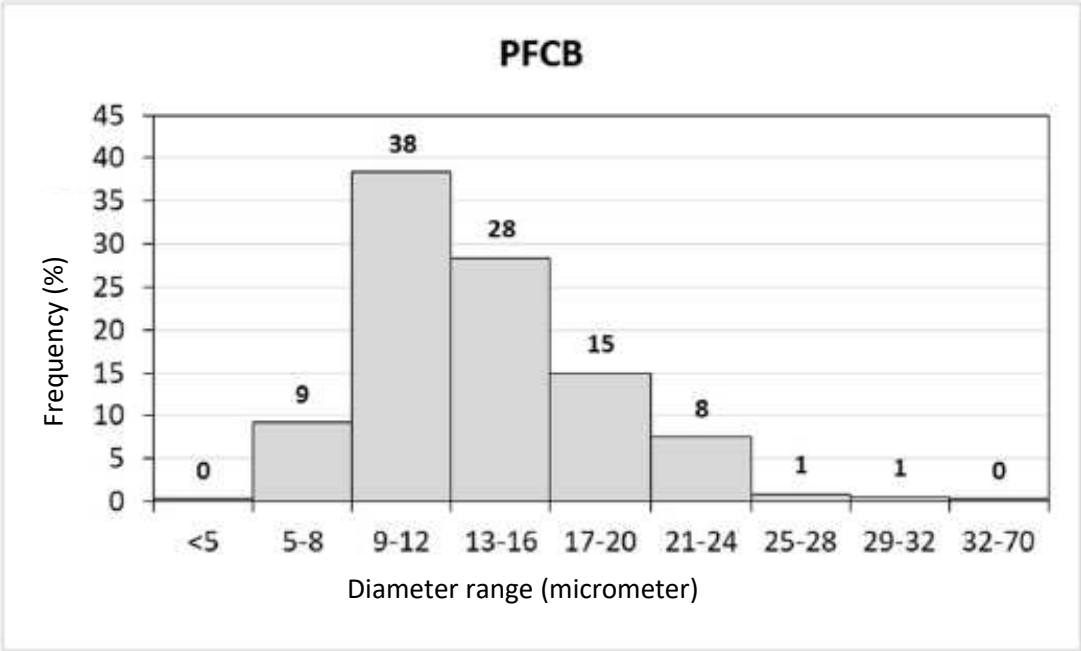

75 um

(A)

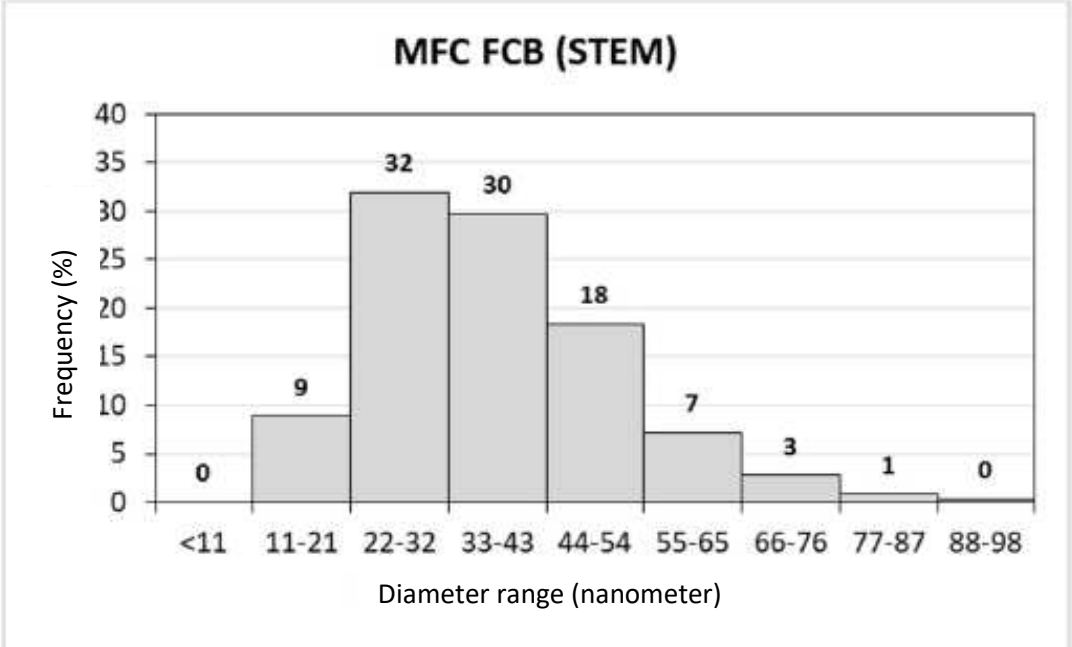

SEM HV: 15.0 kV
WD: 8.00 mm
MIRA3 TESCAN
SEM MAG: 7.54 kx
Det: TE Dark
5 µm
View field: 27.5 µm
Date(m/d/y): 10/18/17
Performance in nanospace

(B)

Figure 5

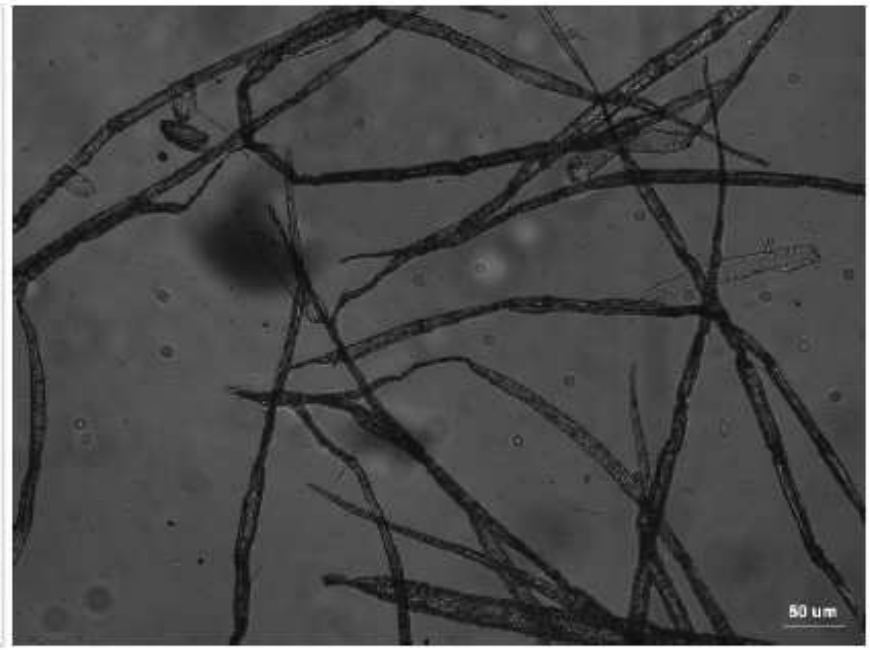

PFCB
Frequency (%)
45
40
35
30
25
20
15
10
5
0
0
9
38
28
15
8
1
1
0
<5
5-8
9-12
13-16
17-20
21-24
25-28
29-32
32-70
Diameter range (micrometer)

(A)

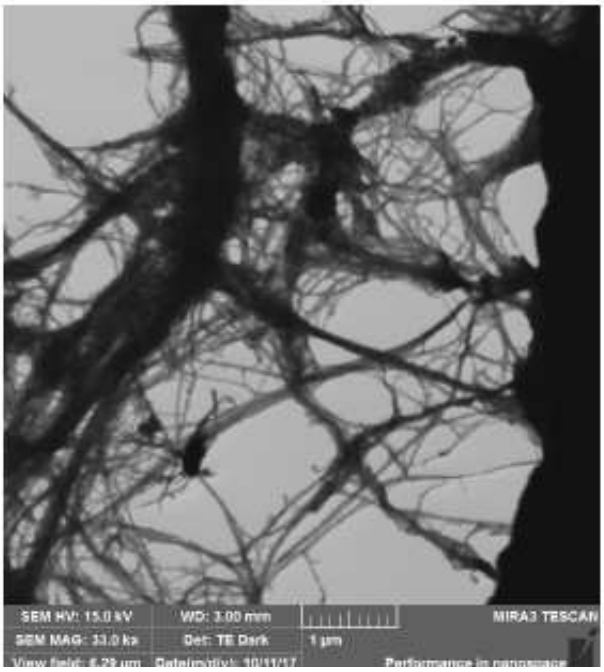

MFC FCB (STEM)
Frequency (%)
40
35
30
25
20
15
10
5
0
0
9
32
30
18
7
3
1
0
<11
11-21
22-32
33-43
44-54
55-65
66-76
77-87
88-98
Diameter range (nanometer)

(B)

Figure 6


50 um

(A)


SEM HV: 15.0 kV
WD: 3.00 mm
MIRA3 TESCAN
SEM MAG: 33.0 kx
Det: TE Dark
1 µm

(B)

Figure 7

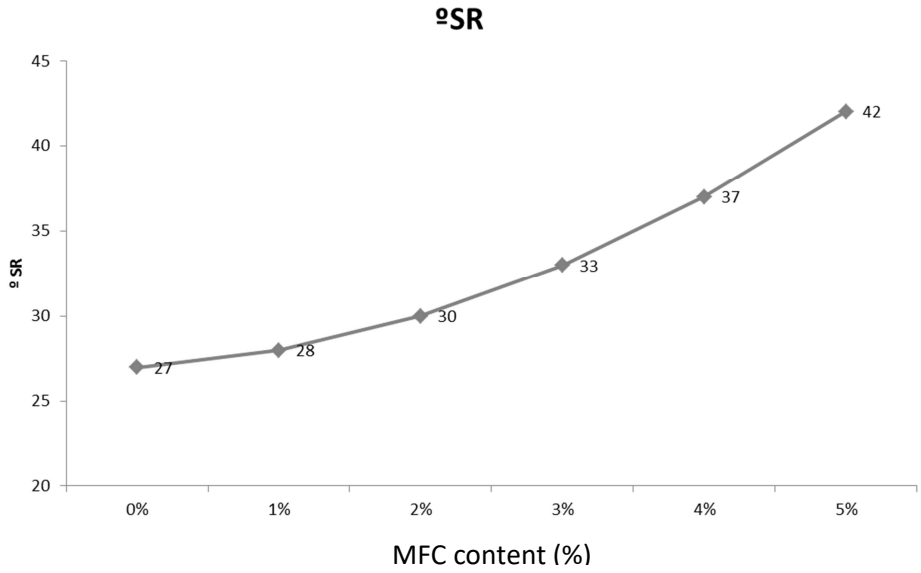


Figure 8

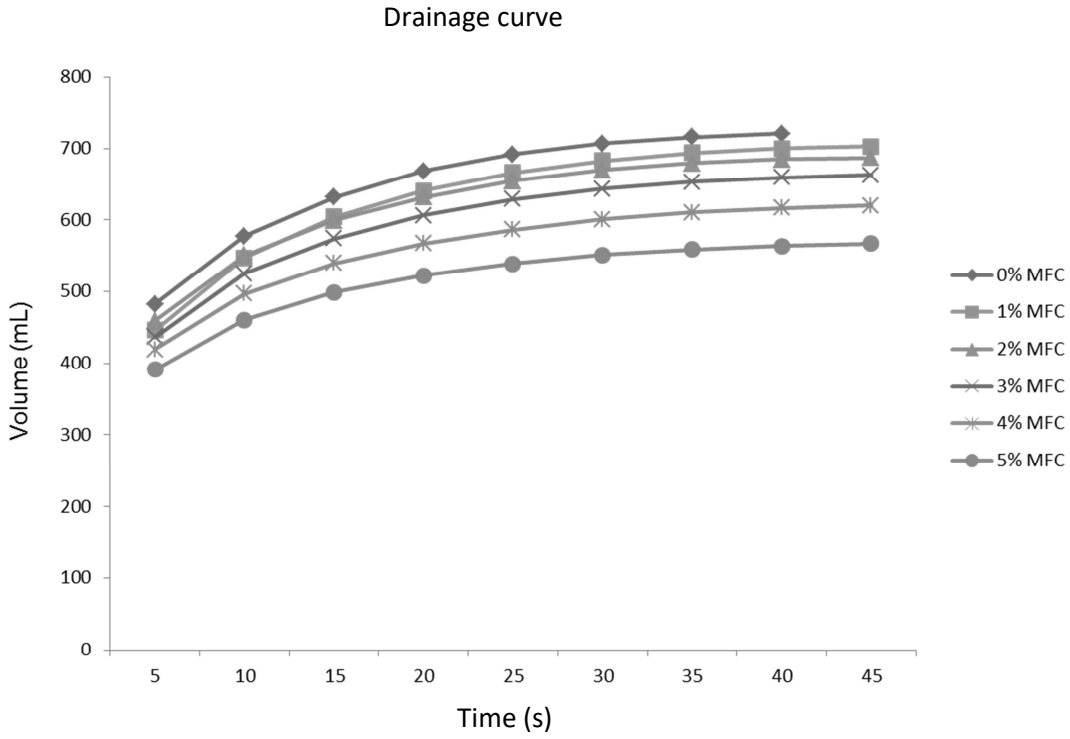
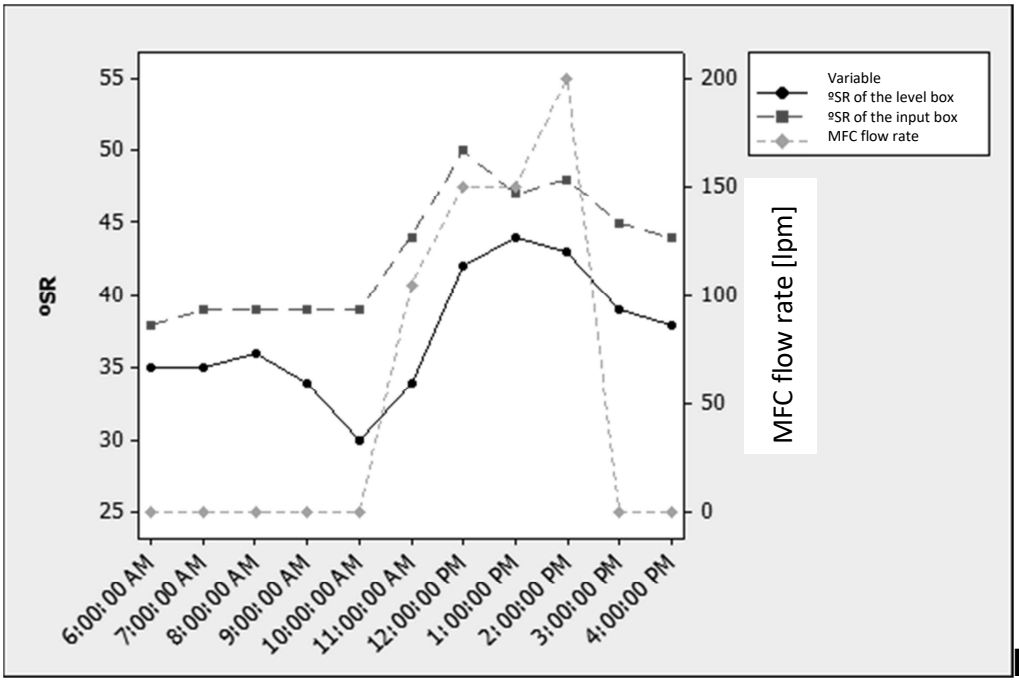


Figure 9



b

Figure 10

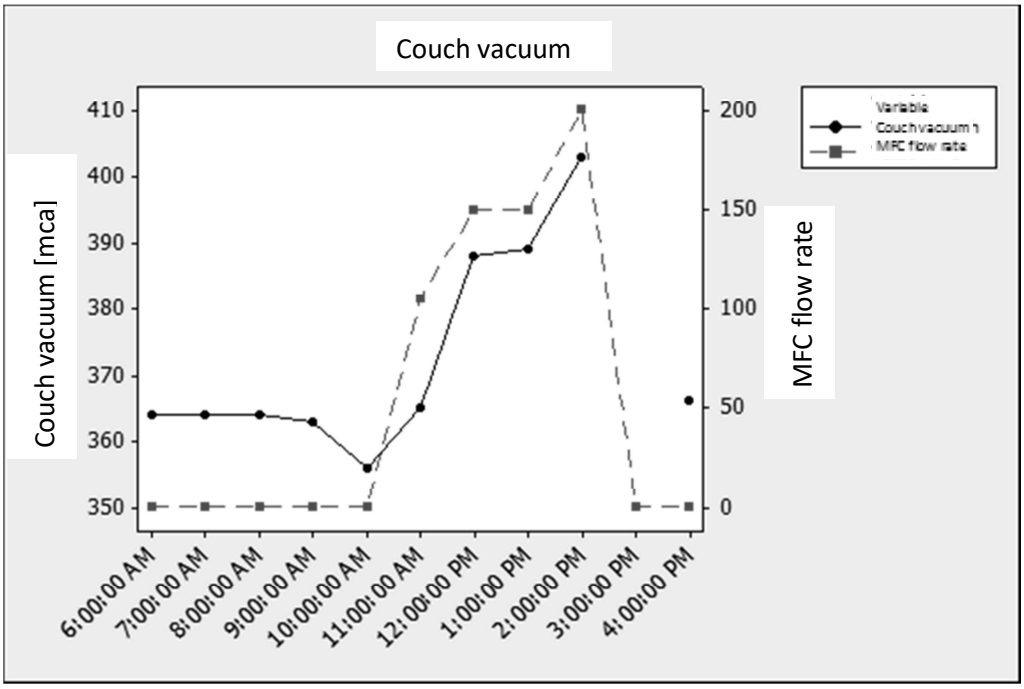


Figure 11

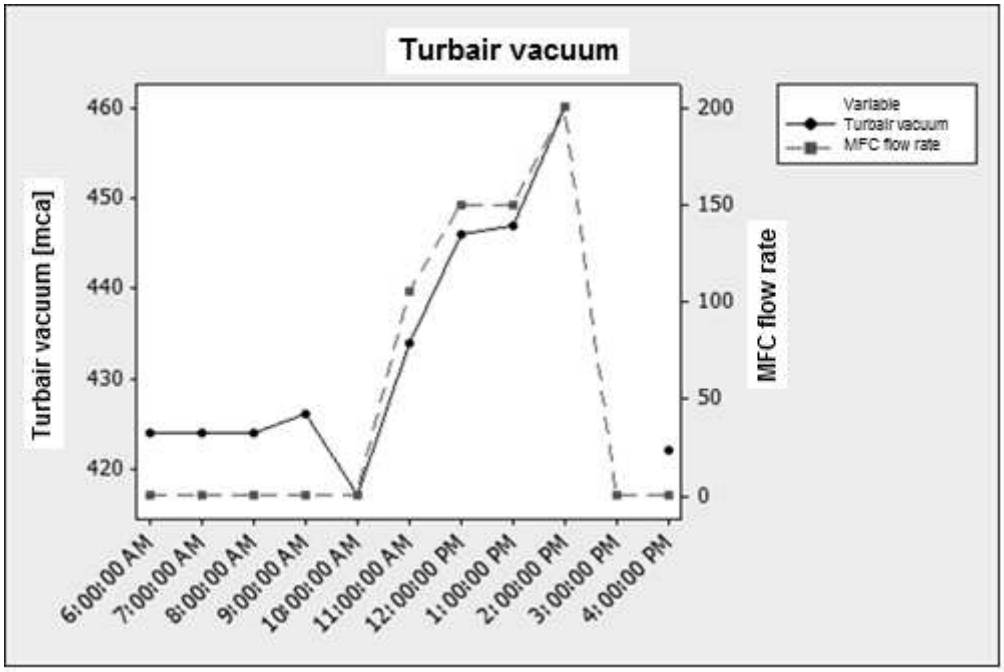


Figure 12

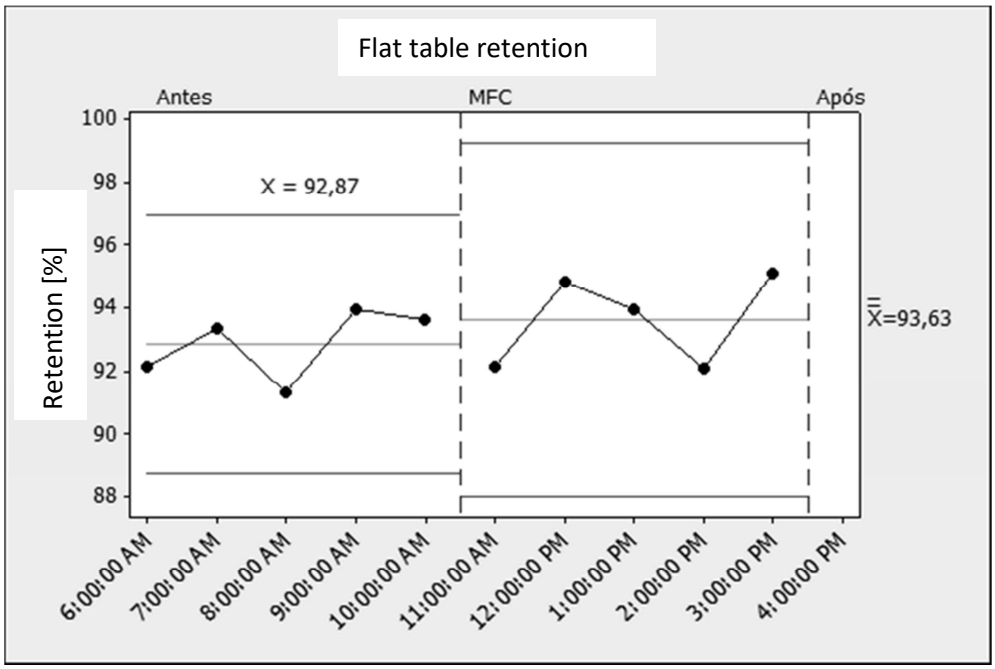


Figure 13

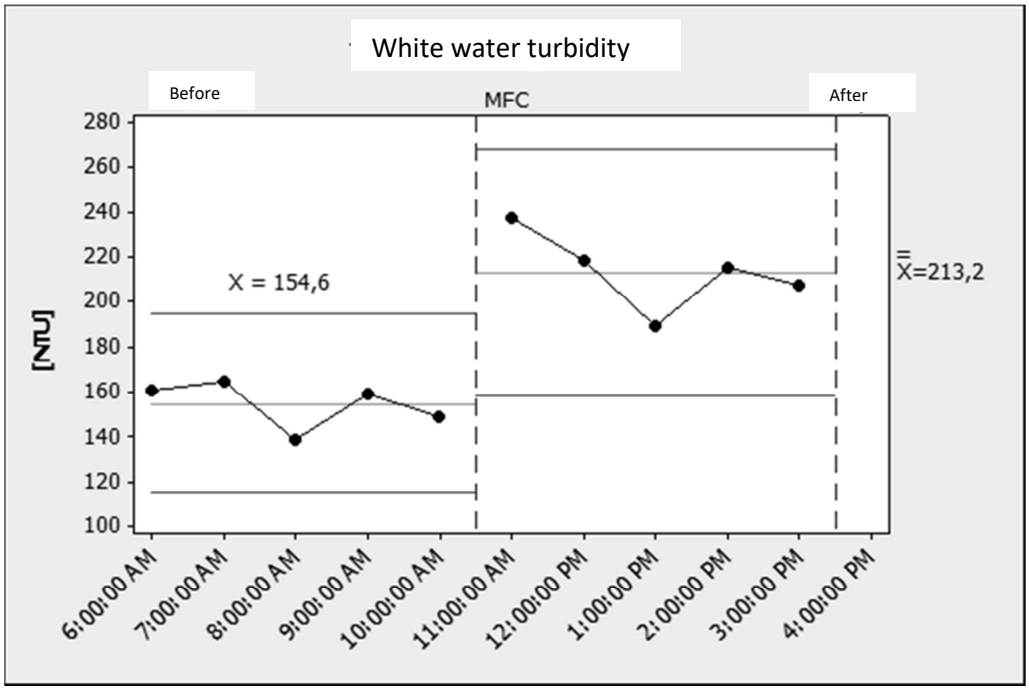


Figure 14

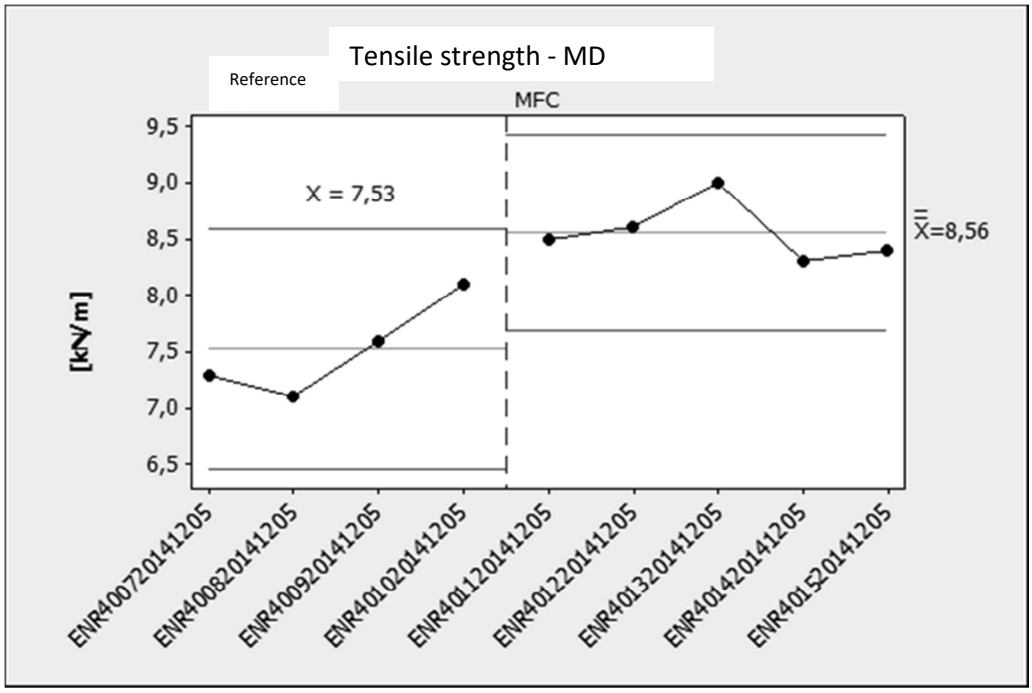


Figure 15

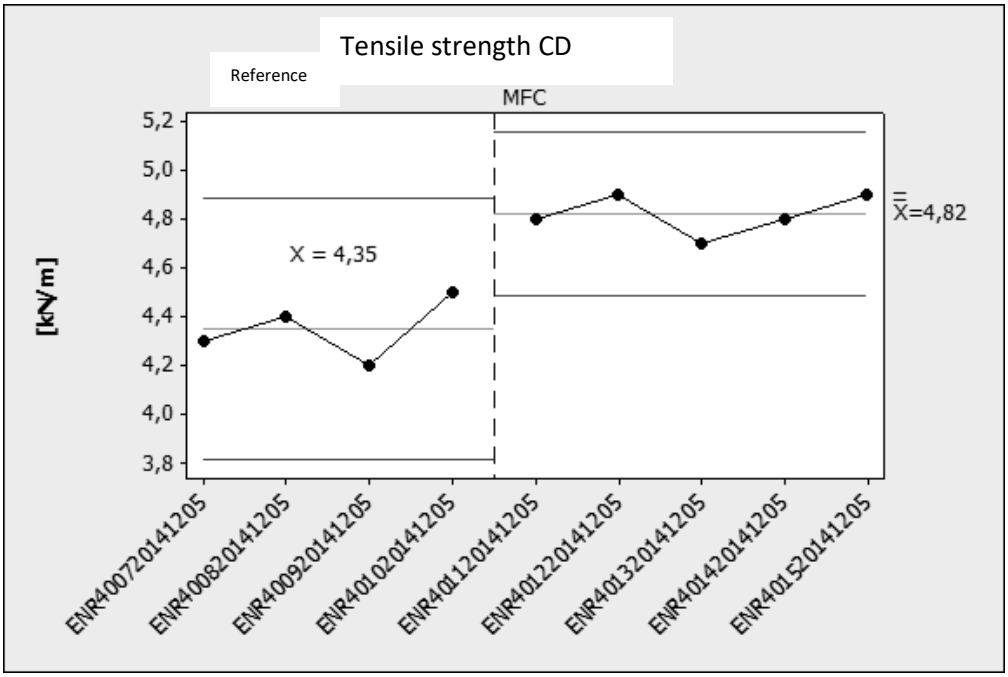


Figure 16

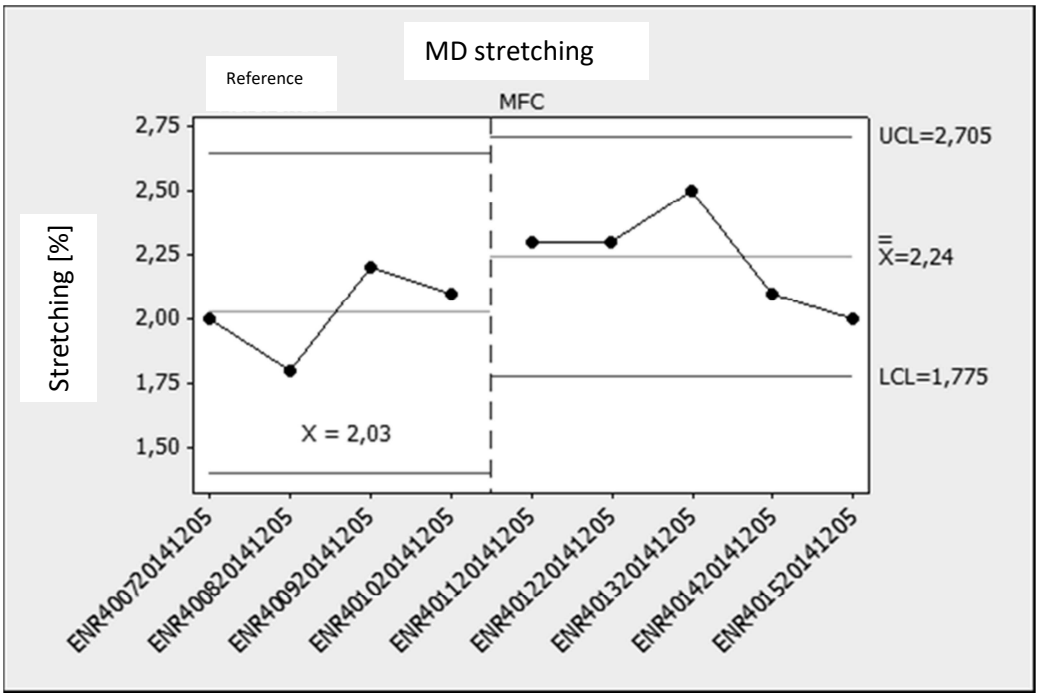


Figure 17

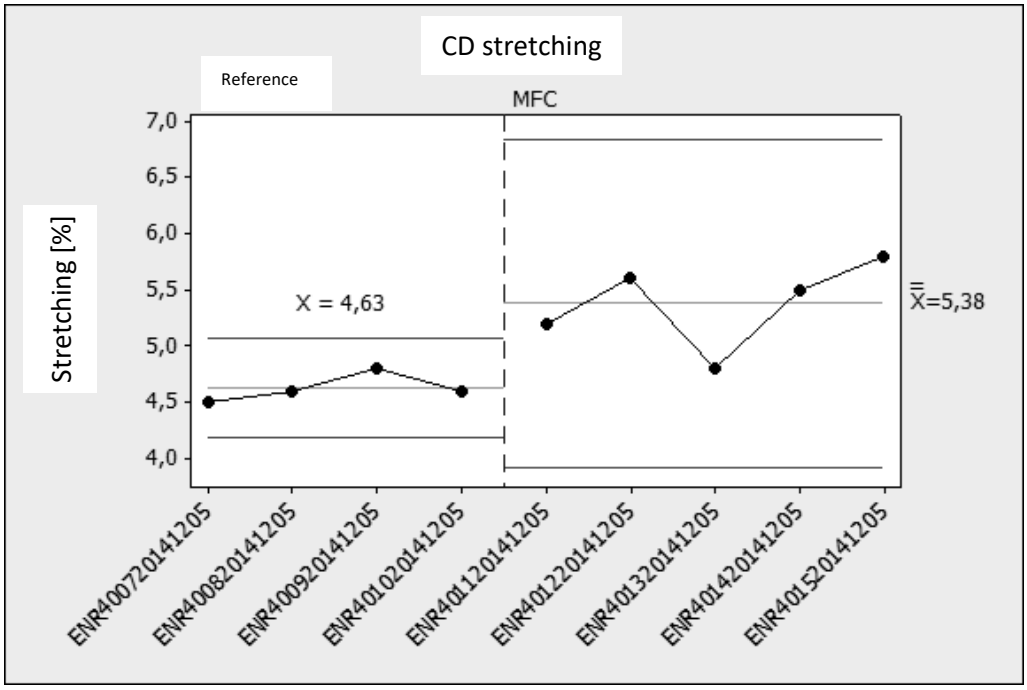


Figure 18

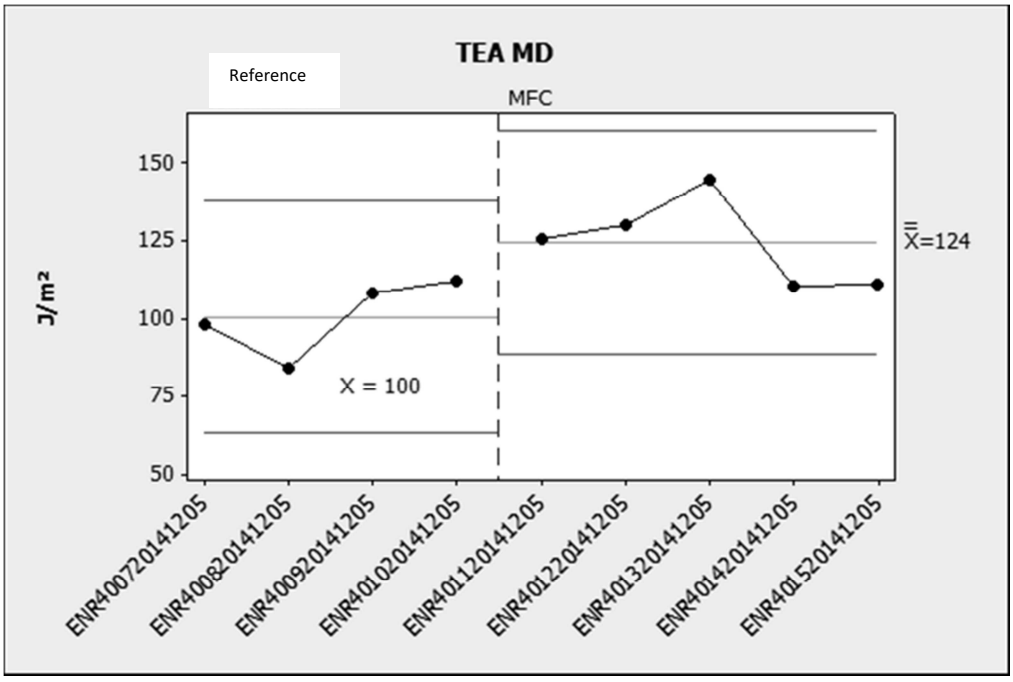


Figure 19

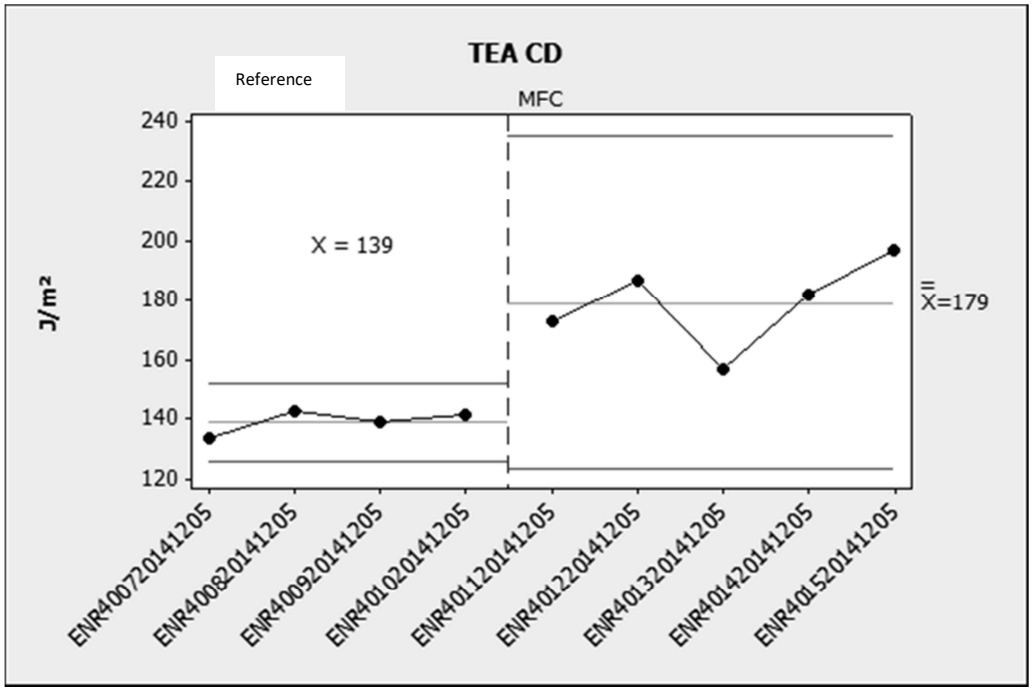


Figure 20

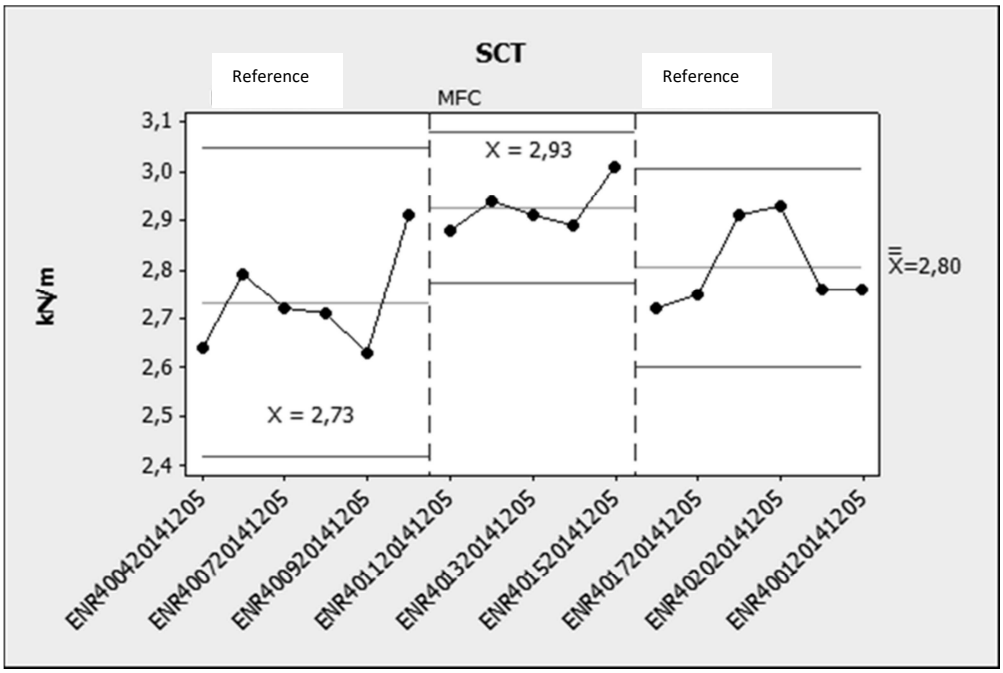


Figure 21

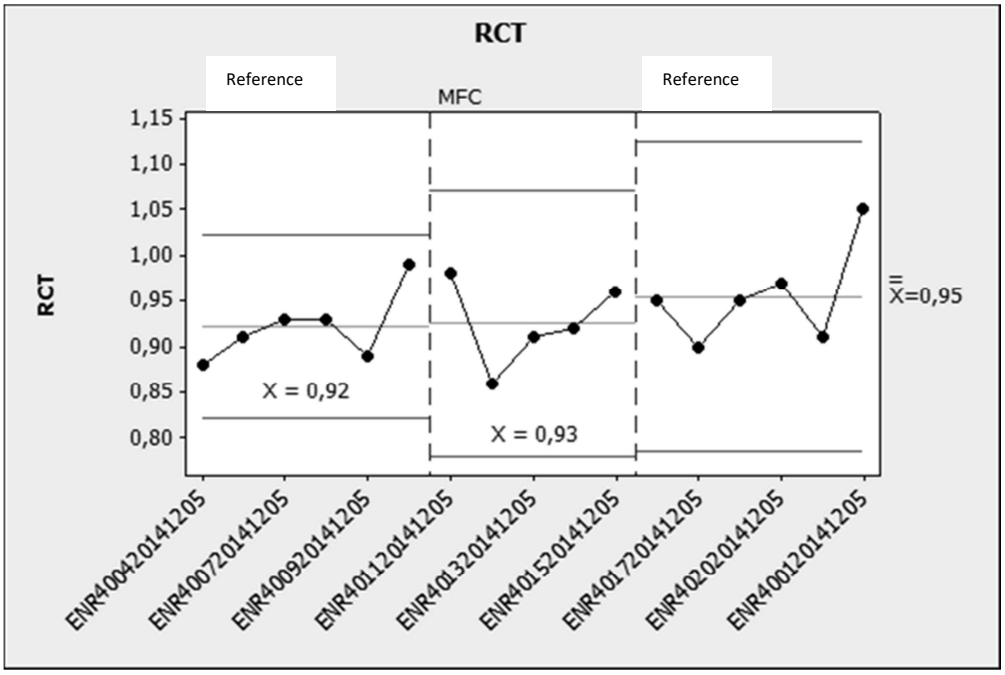


Figure 22

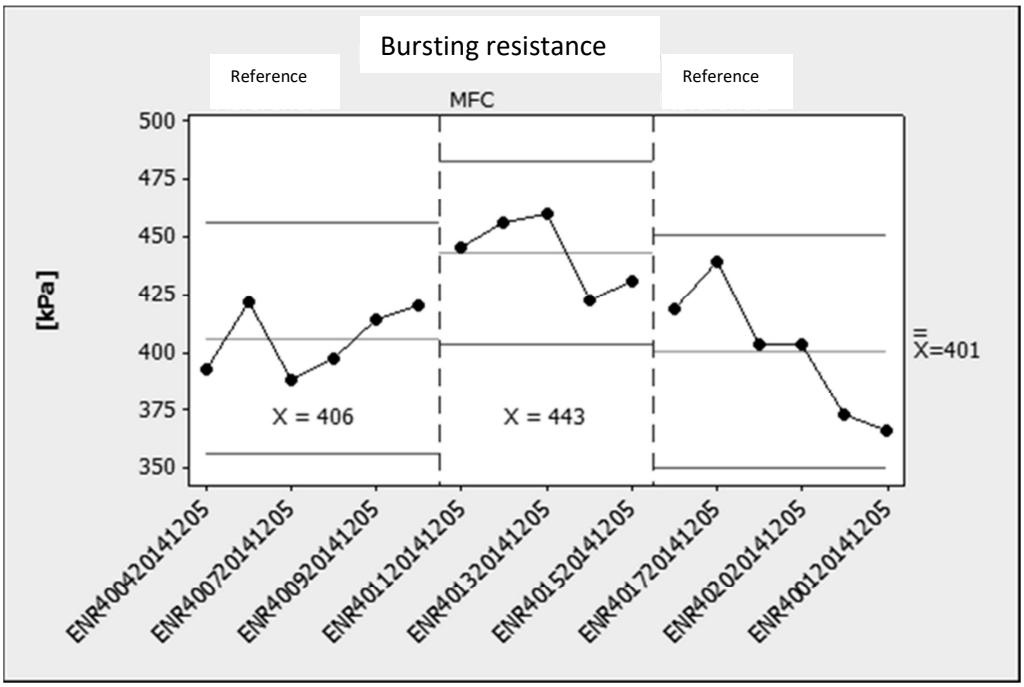


Figure 23

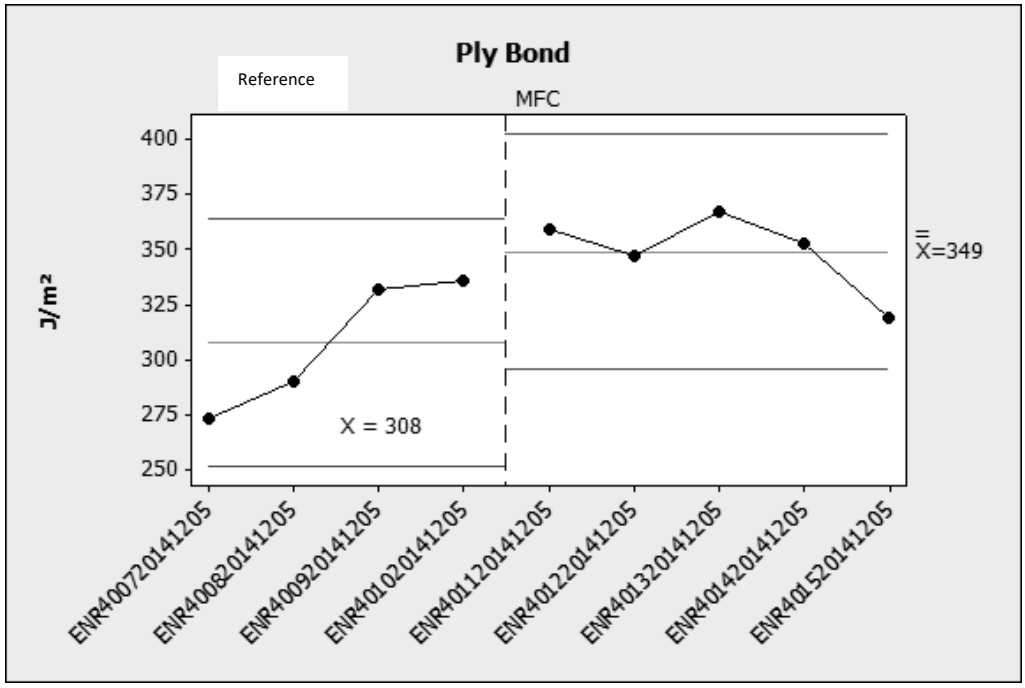


Figure 24

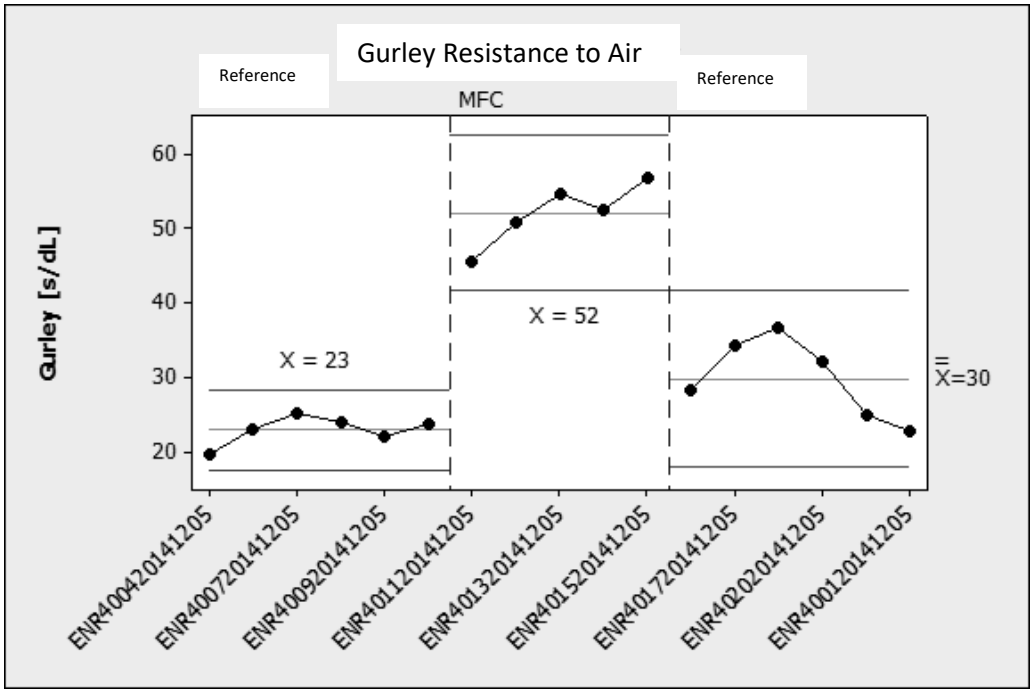


Figure 25

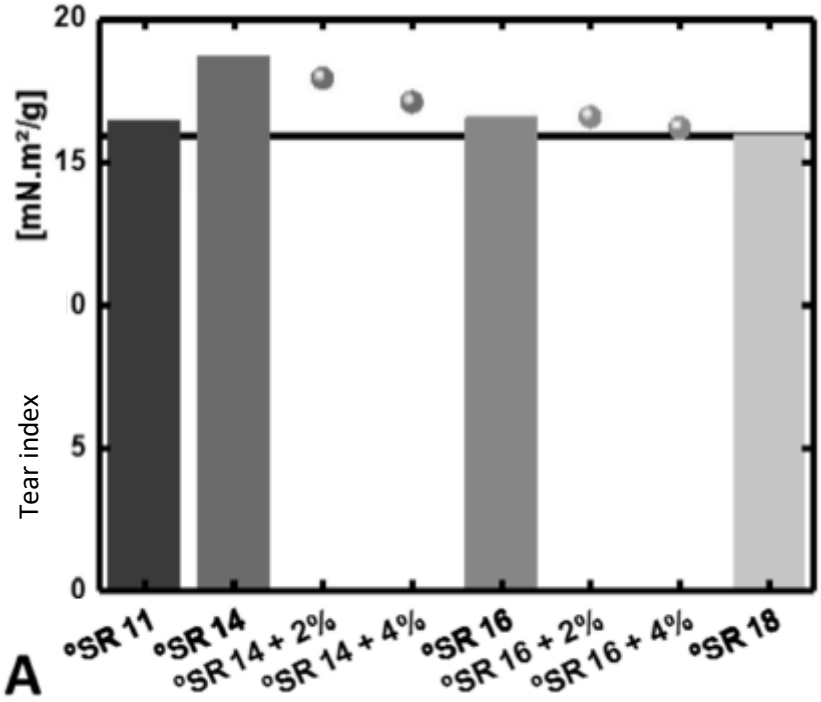

20
15
0
5
0
[mN.m²/g]
Tear index
°SR 11
°SR 14
°SR 14 + 2%
°SR 14 + 4%
°SR 16
°SR 16 + 2%
°SR 16 + 4%
°SR 18
A

Figure 26

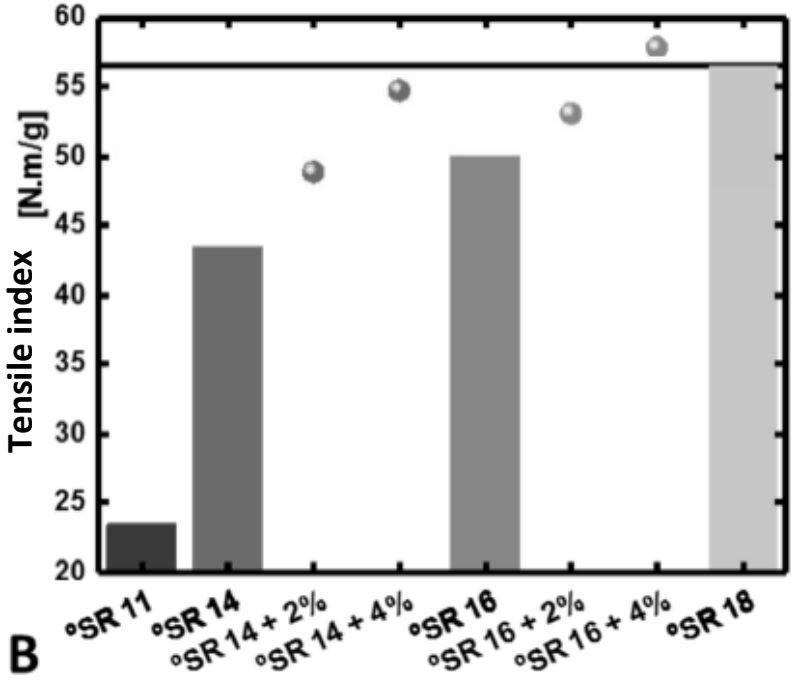


Figure 27

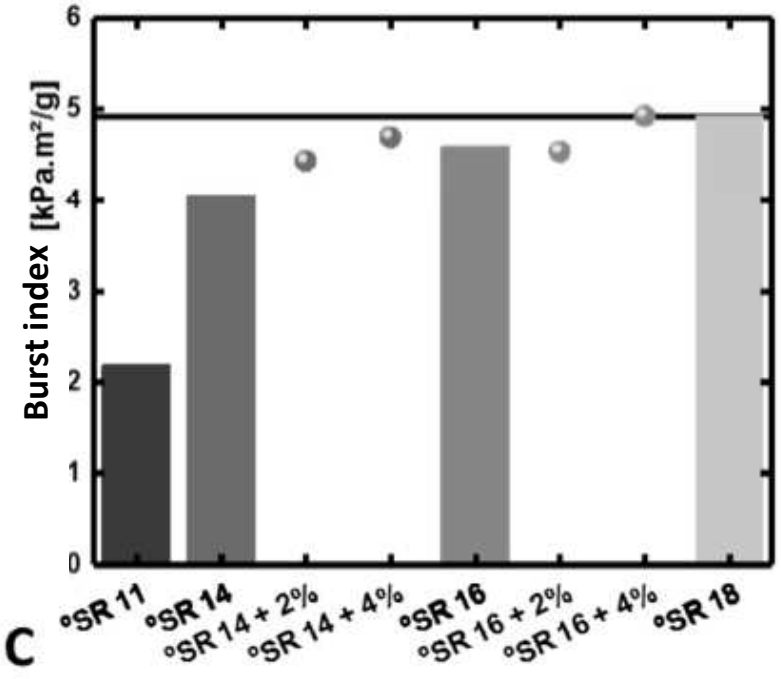


Figure 28

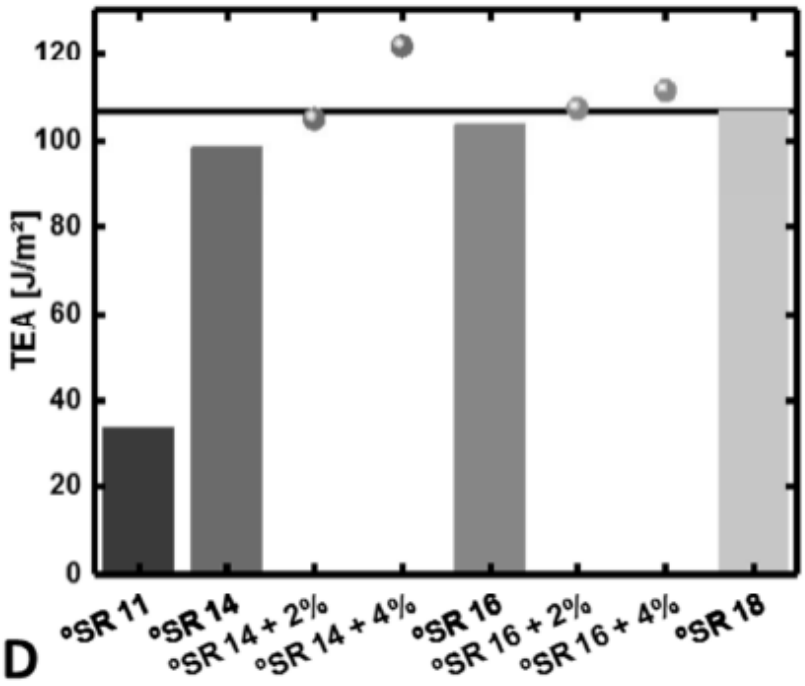


Figure 29

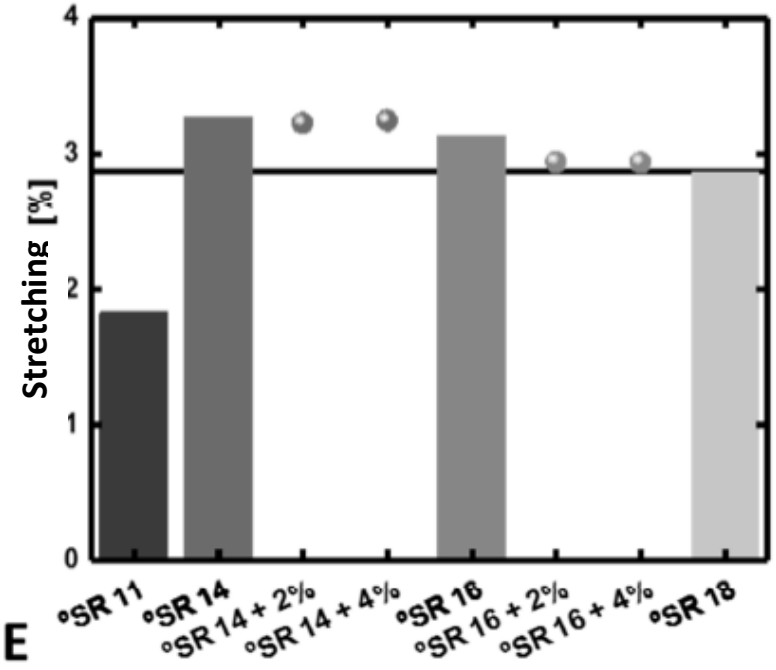


Figure 30

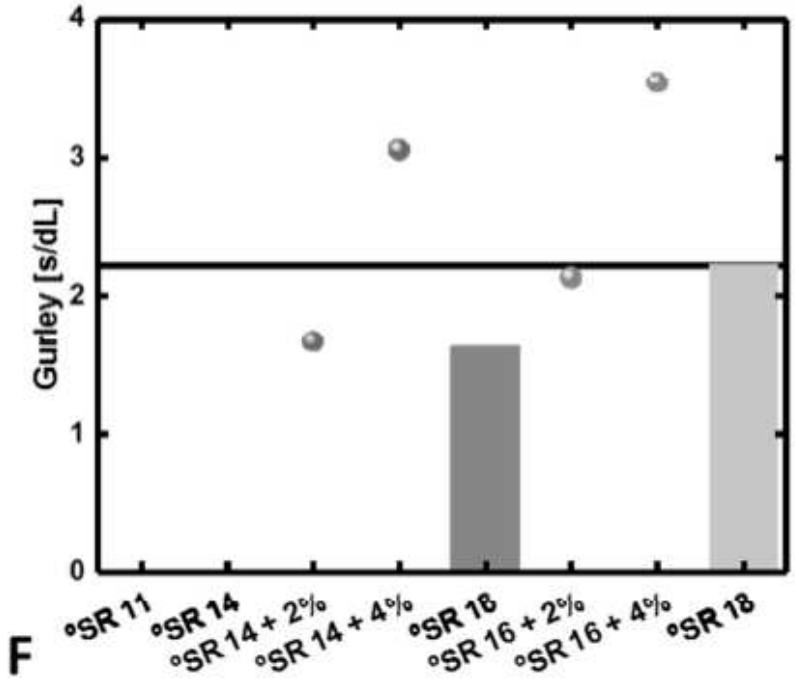


Figure 31

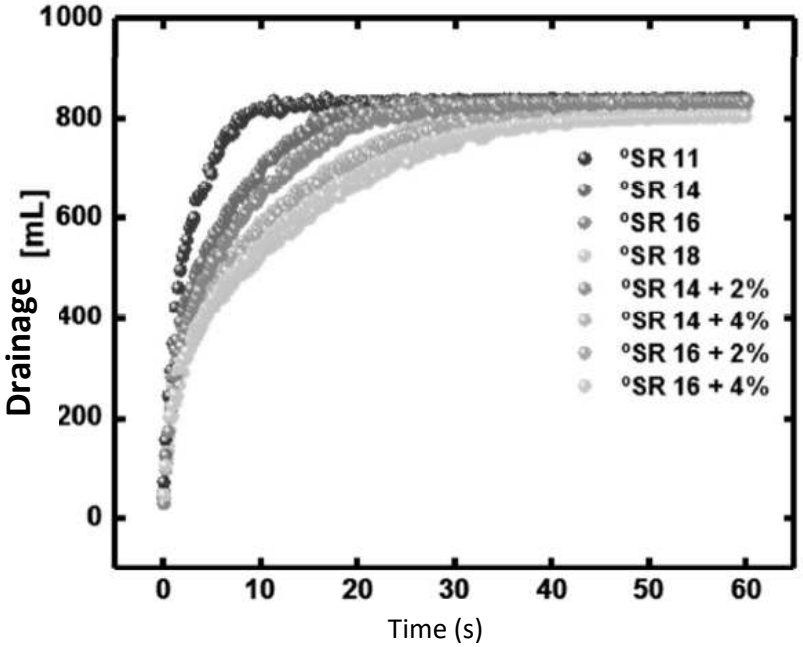


Figure 32

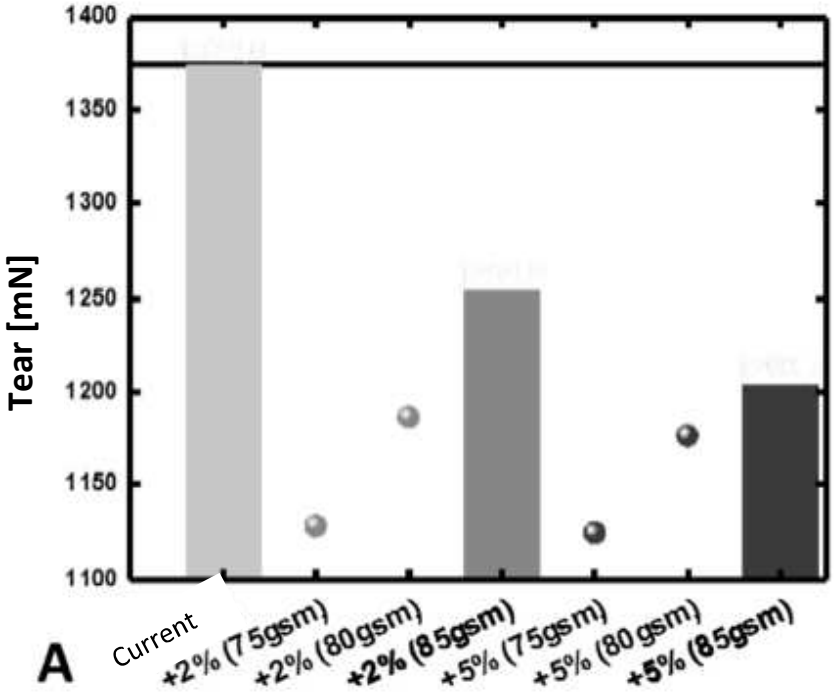


Figure 33

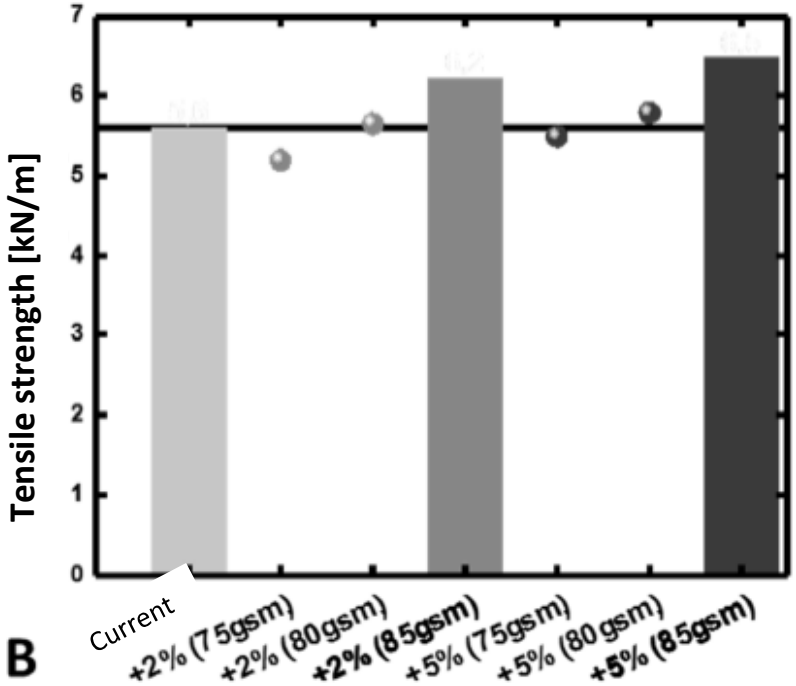


Figure 34

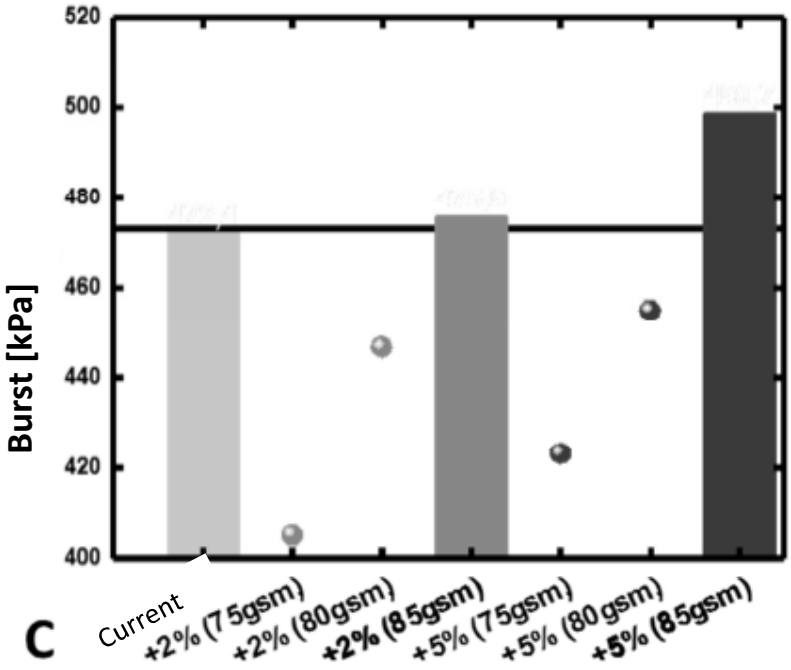


Figure 35

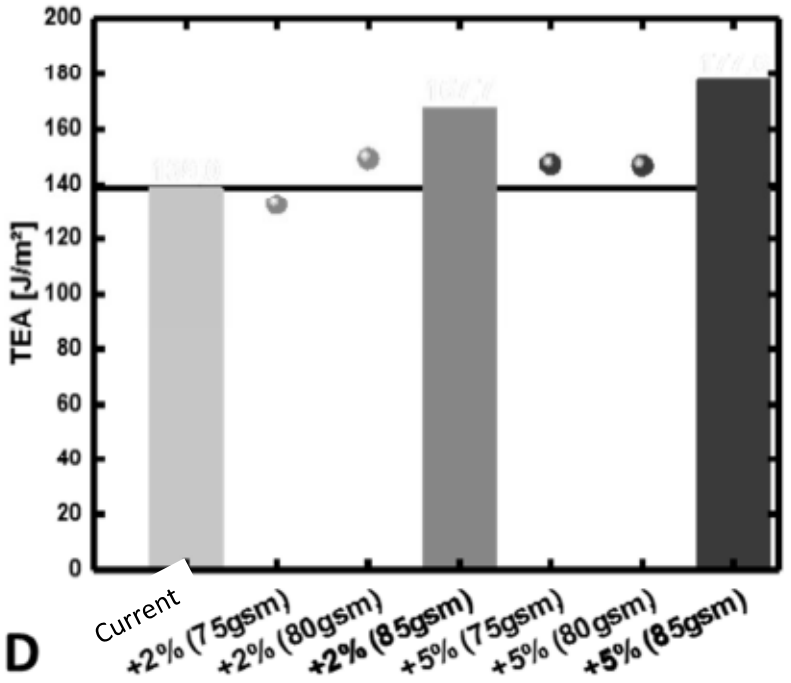


Figure 36

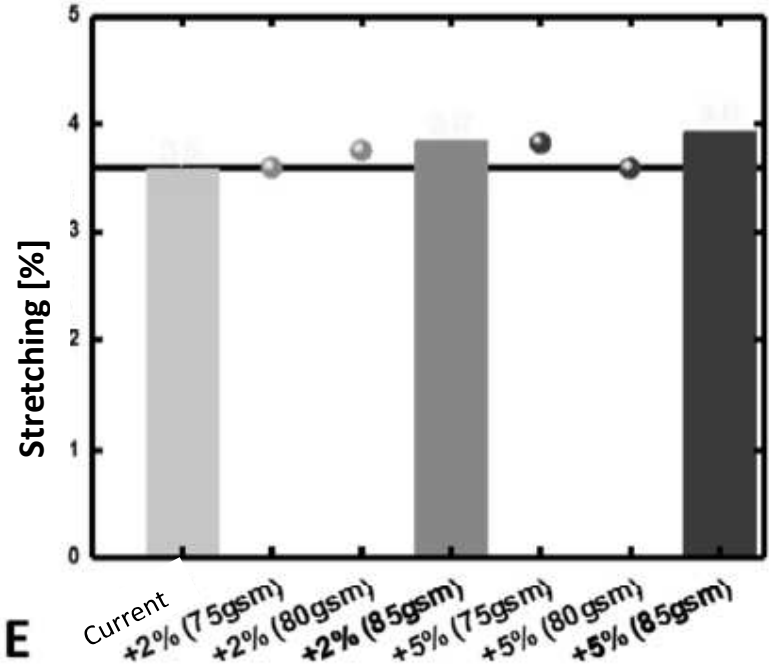


Figure 37

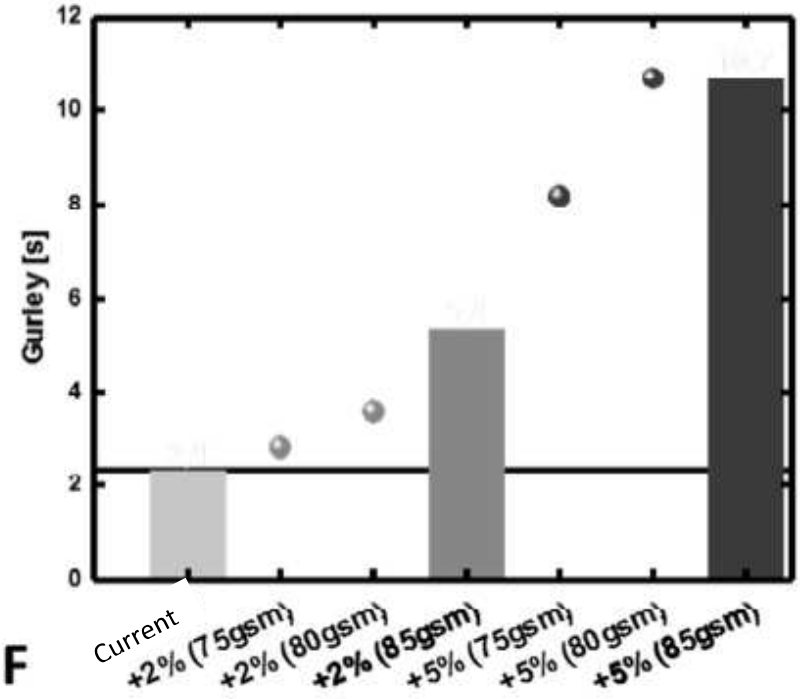


Figure 38

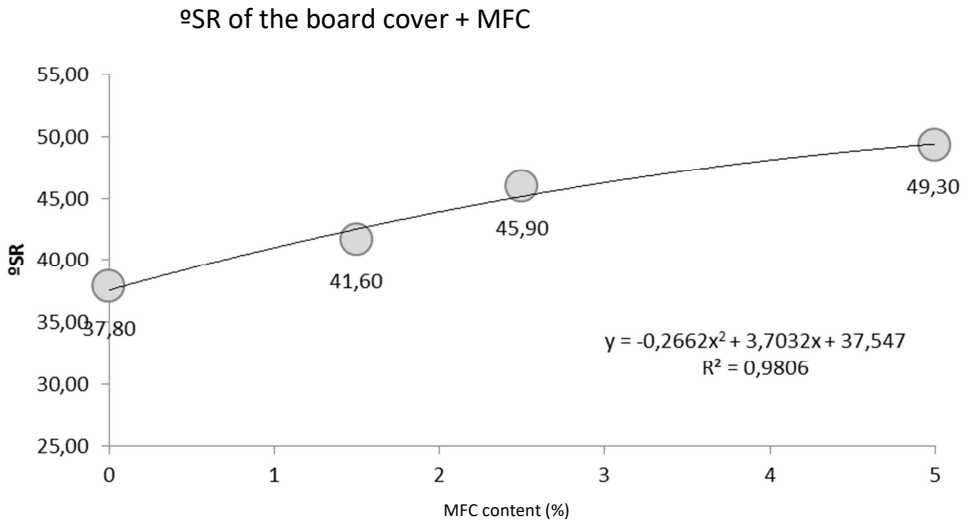


Figure 39

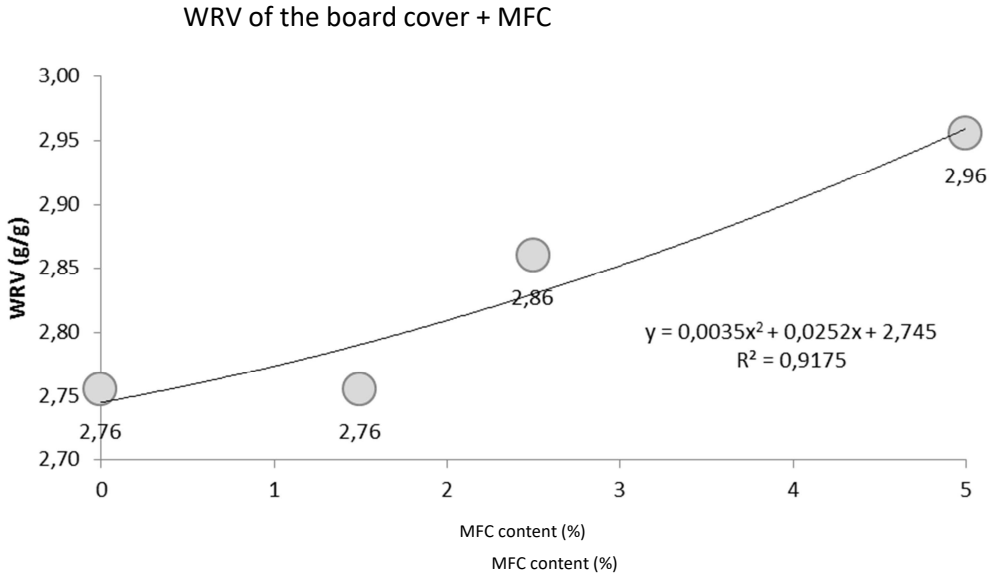


Figure 40

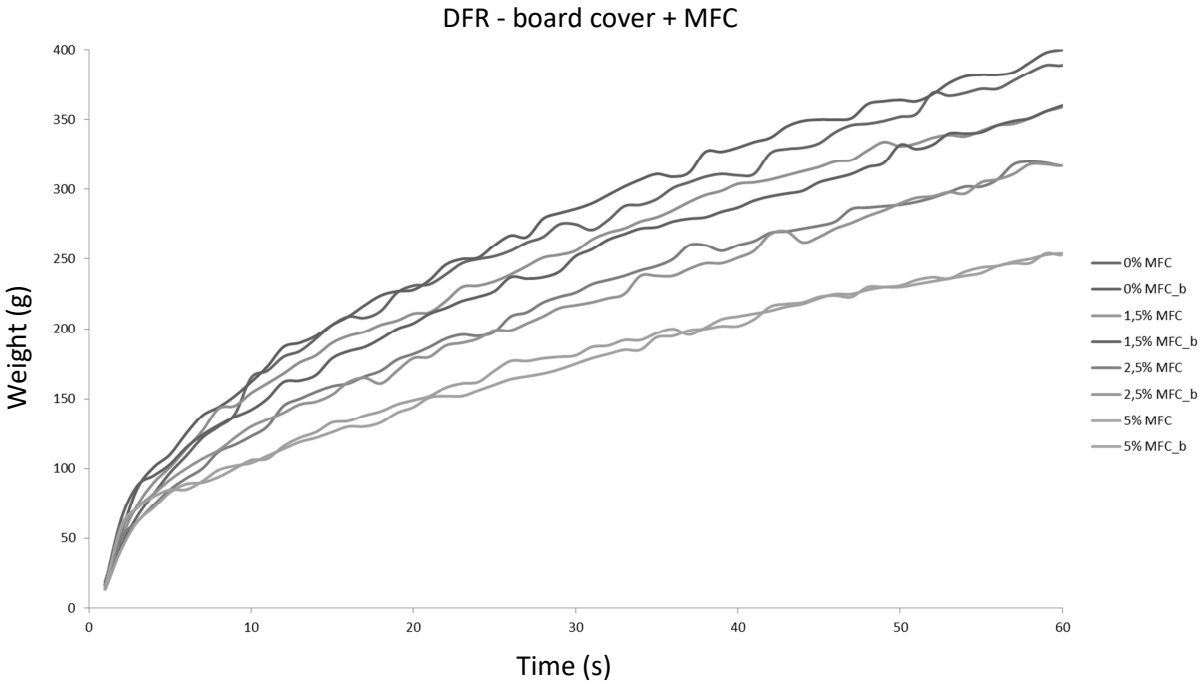


Figure 41

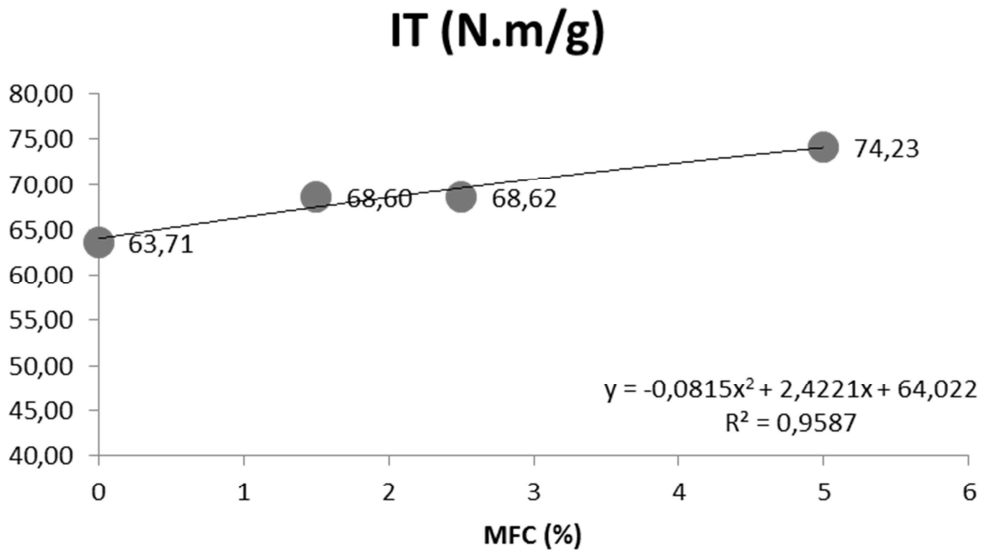


Figure 42

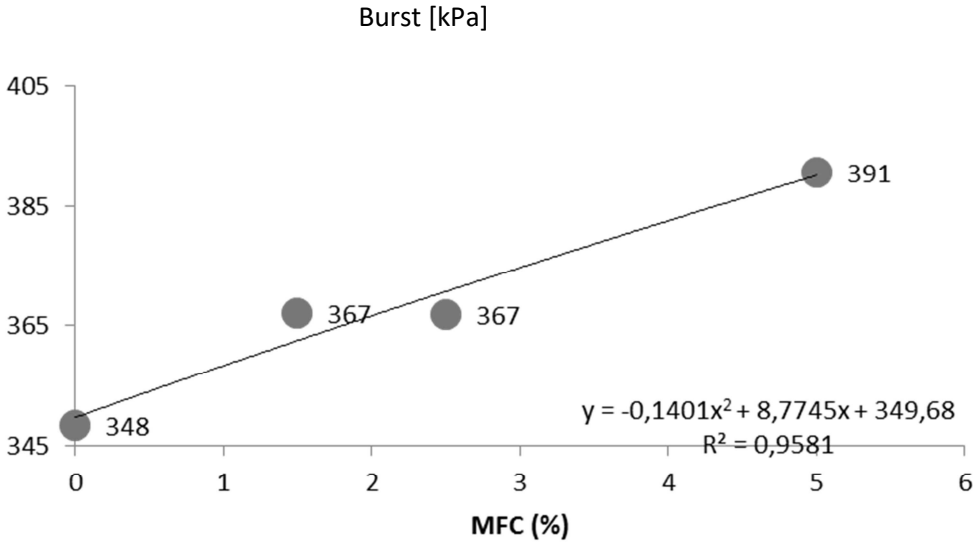


Figure 43

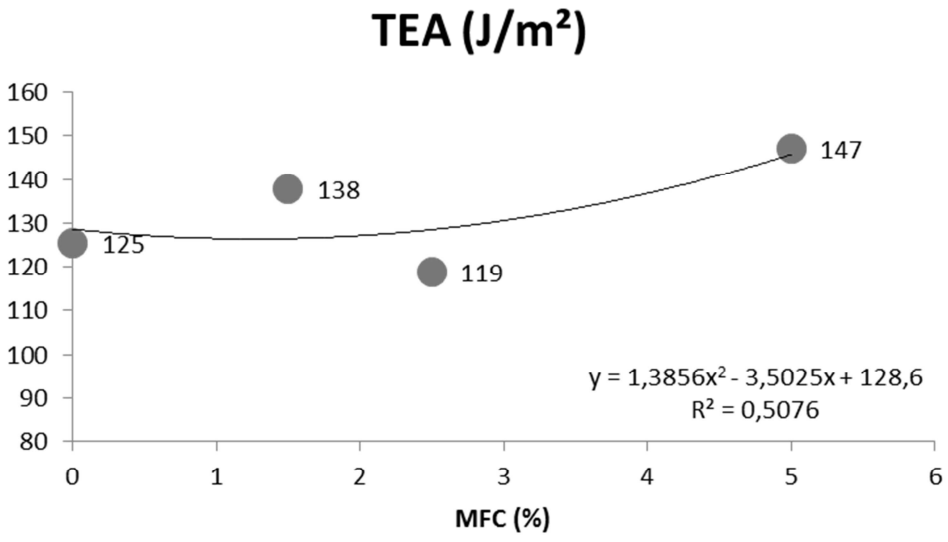


Figure 44

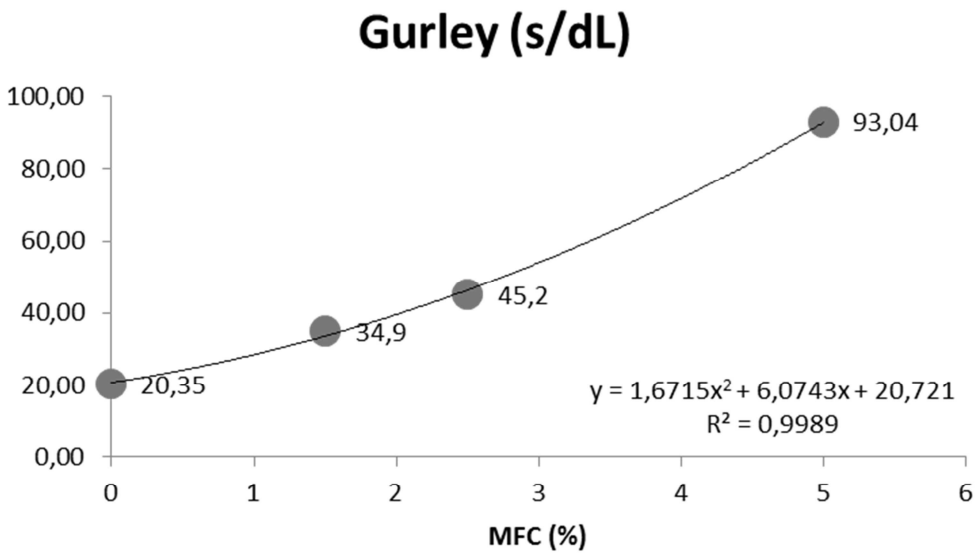


Figure 45

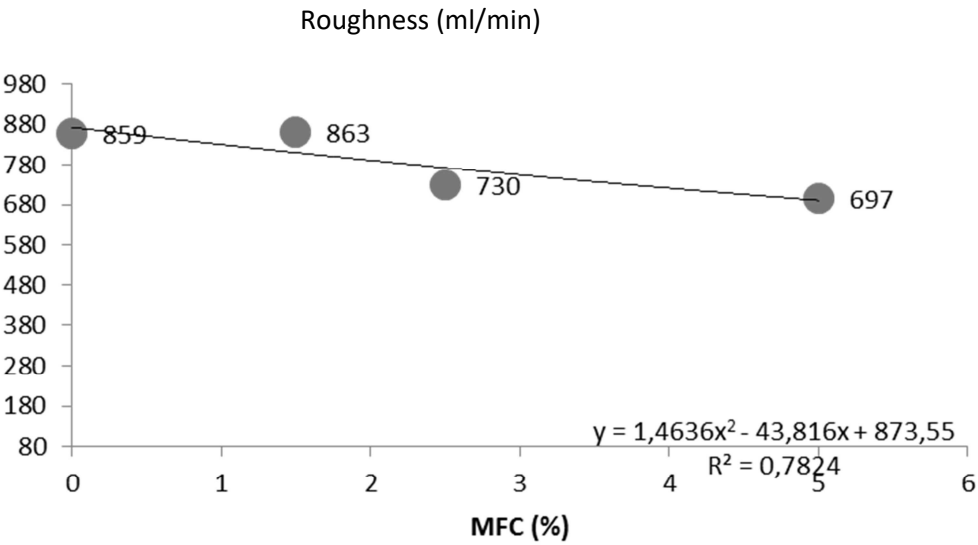
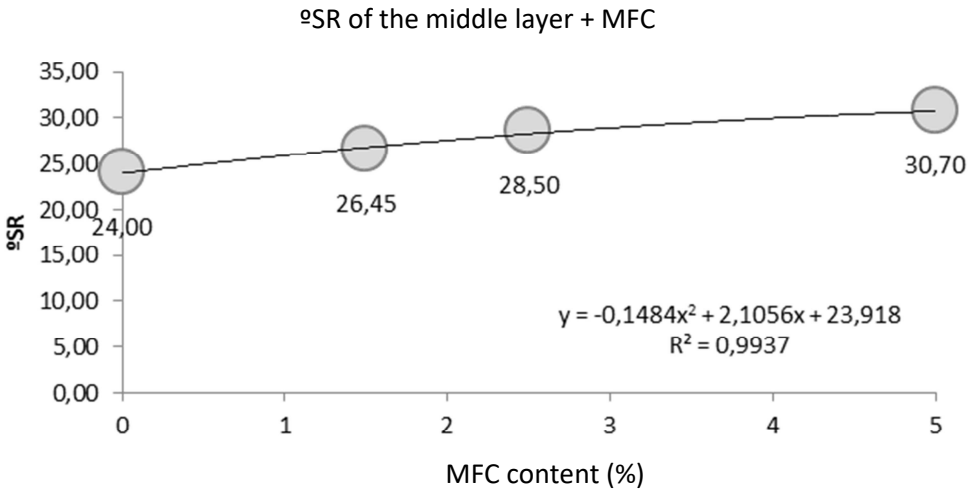


Figure 46



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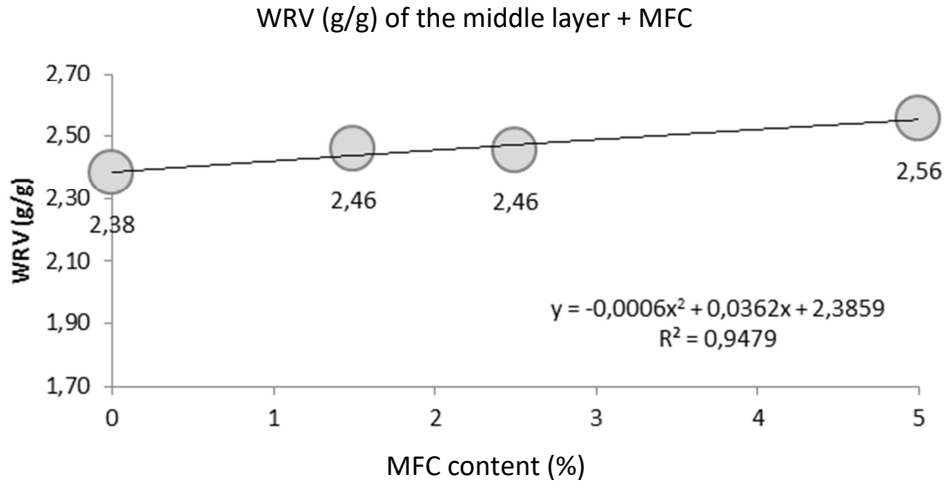

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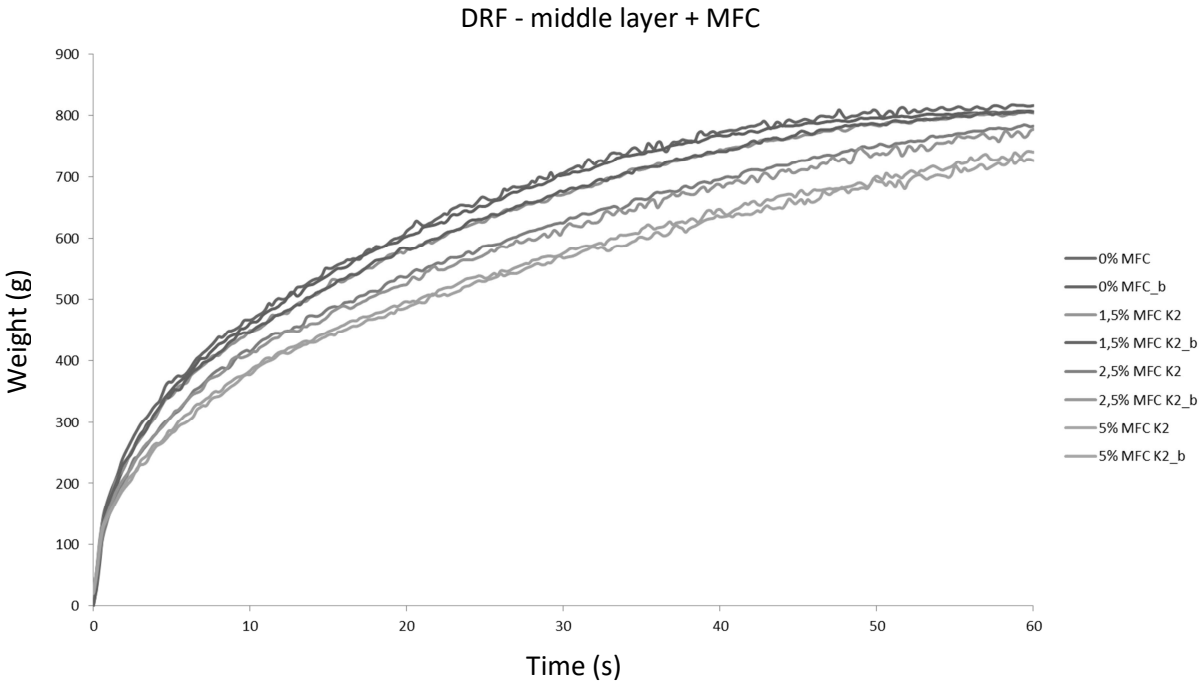

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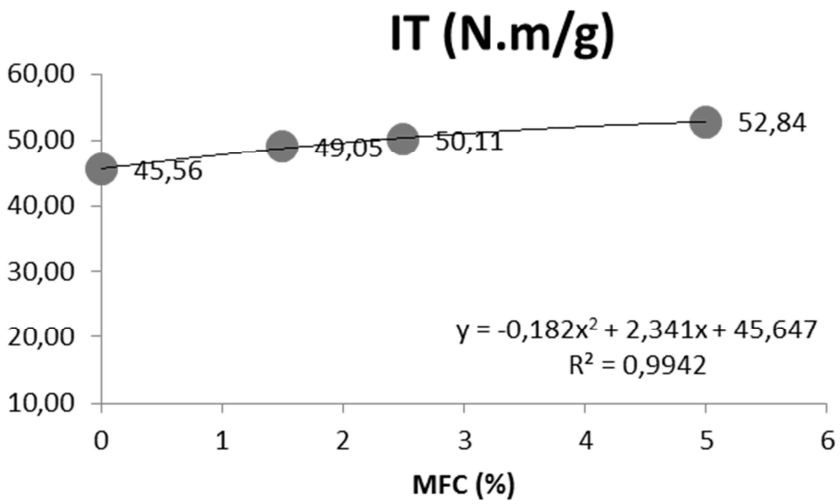

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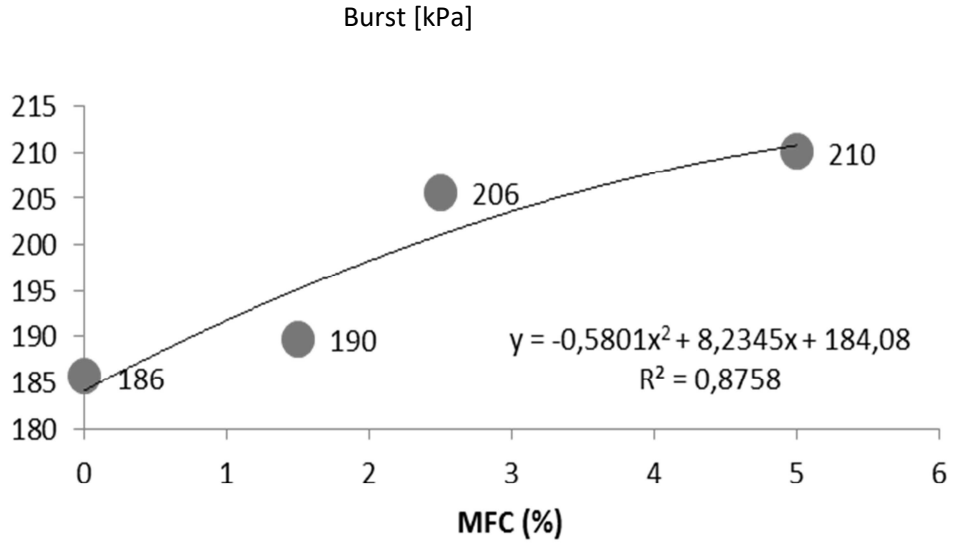

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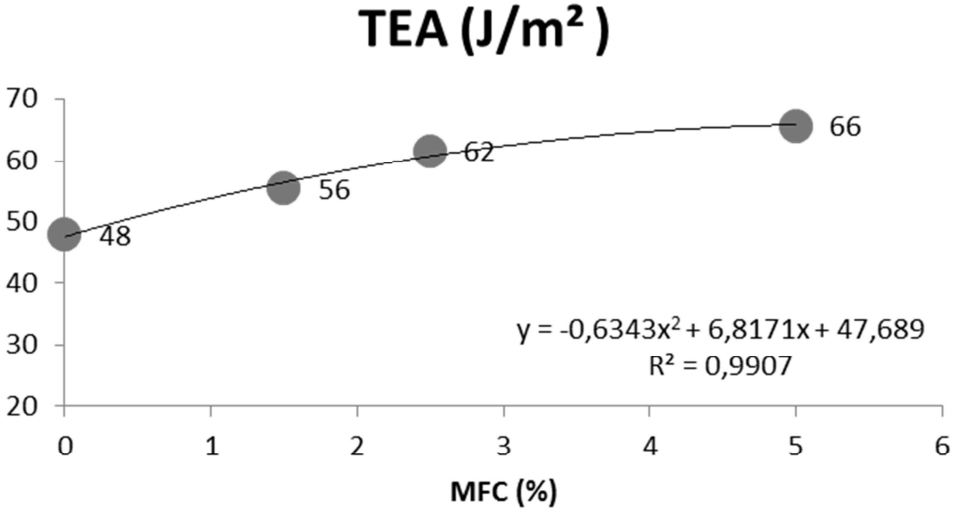

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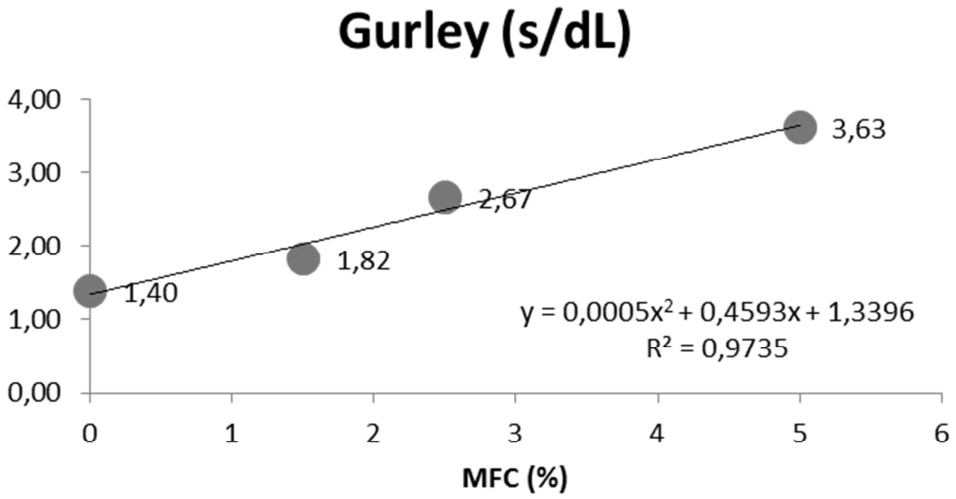

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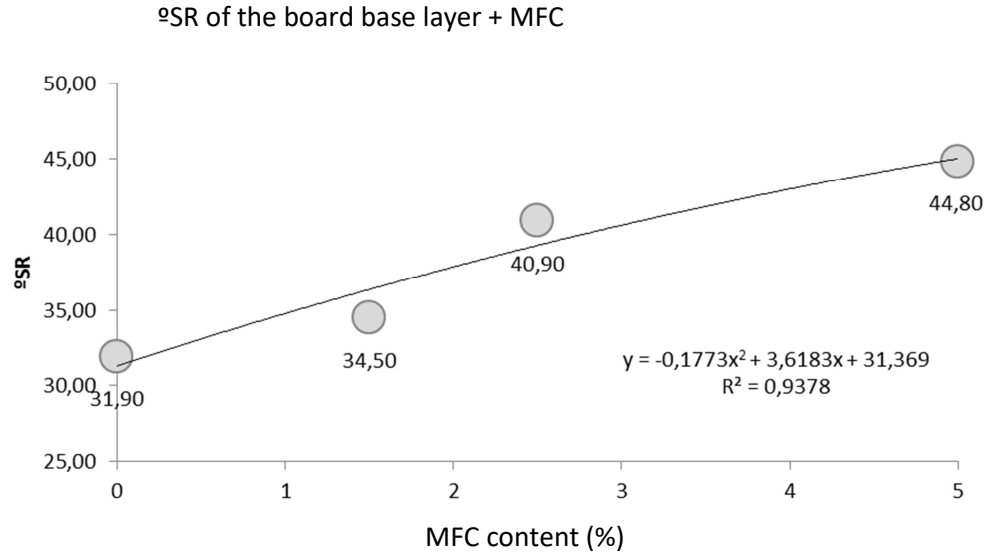

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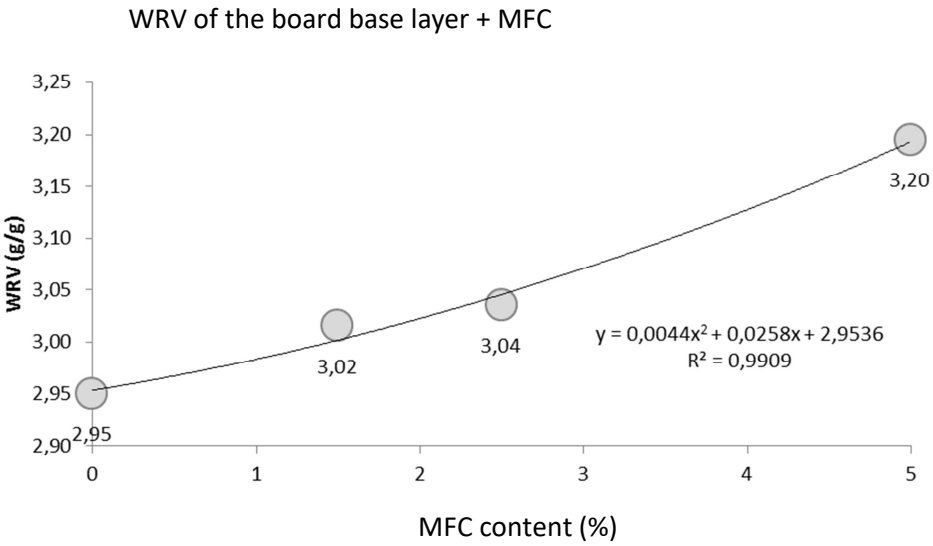

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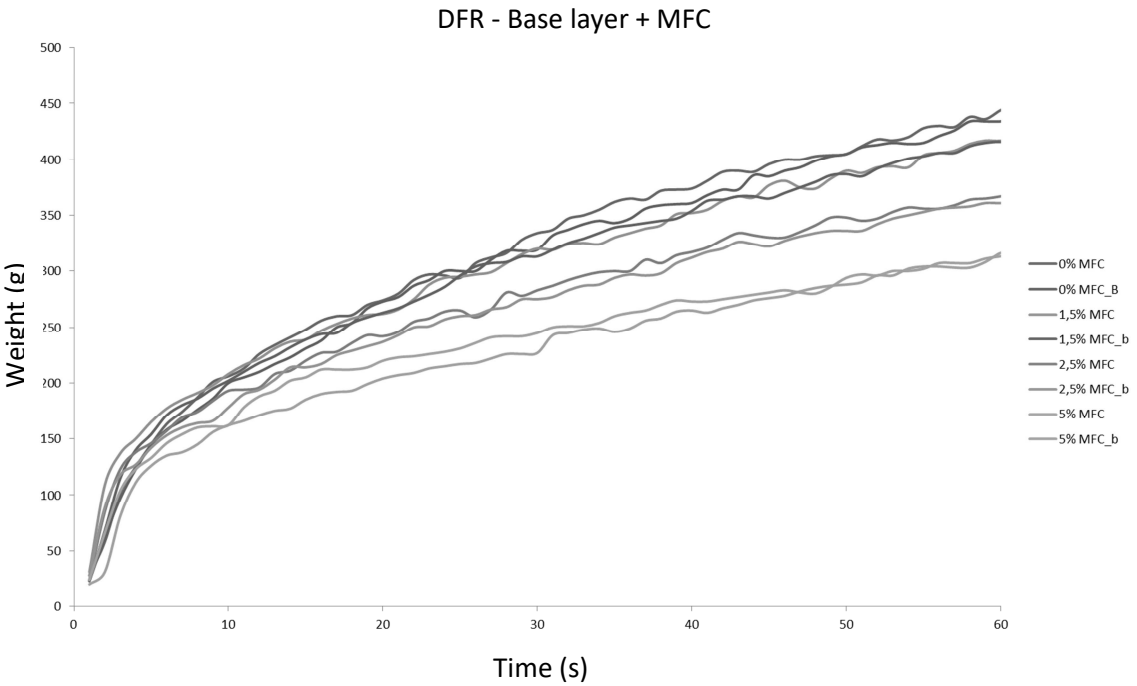

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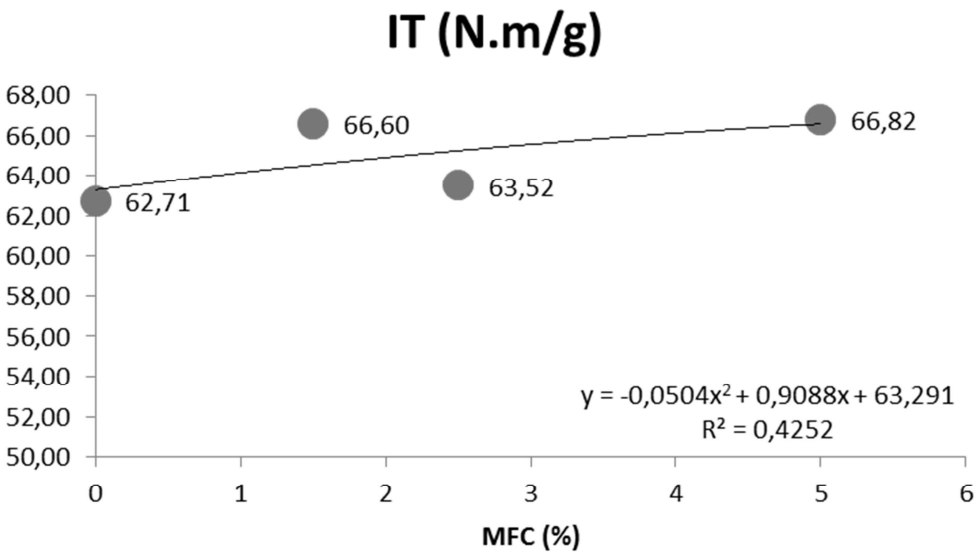

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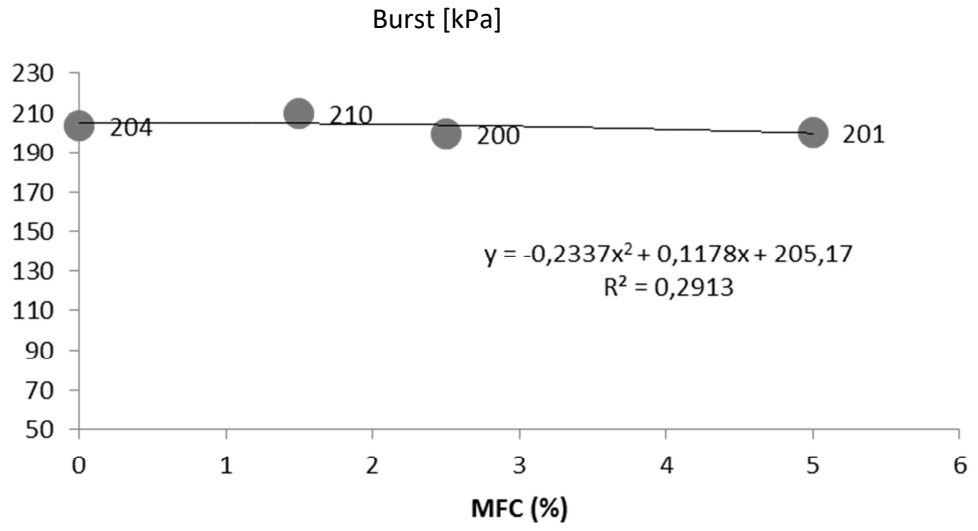

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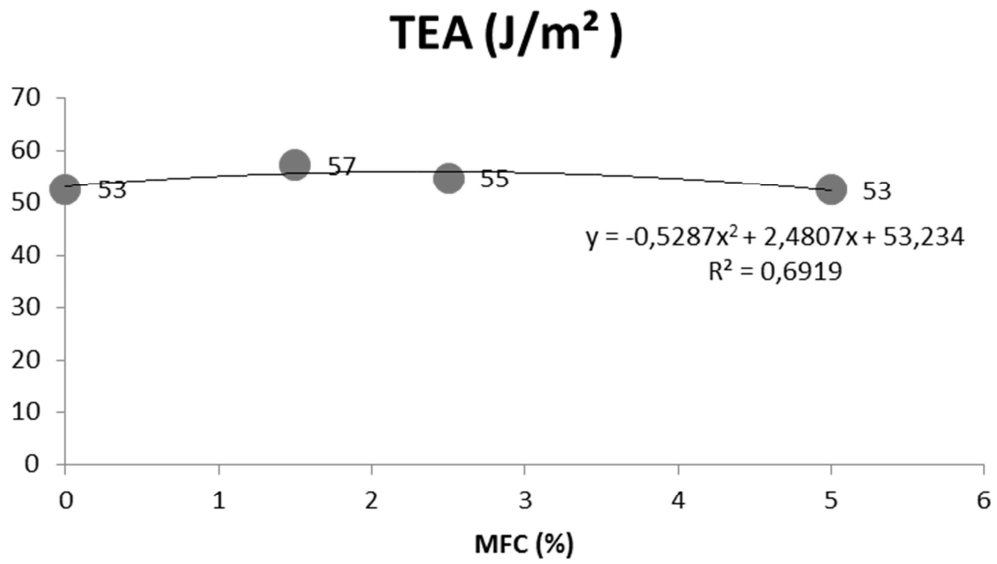

Figure 59

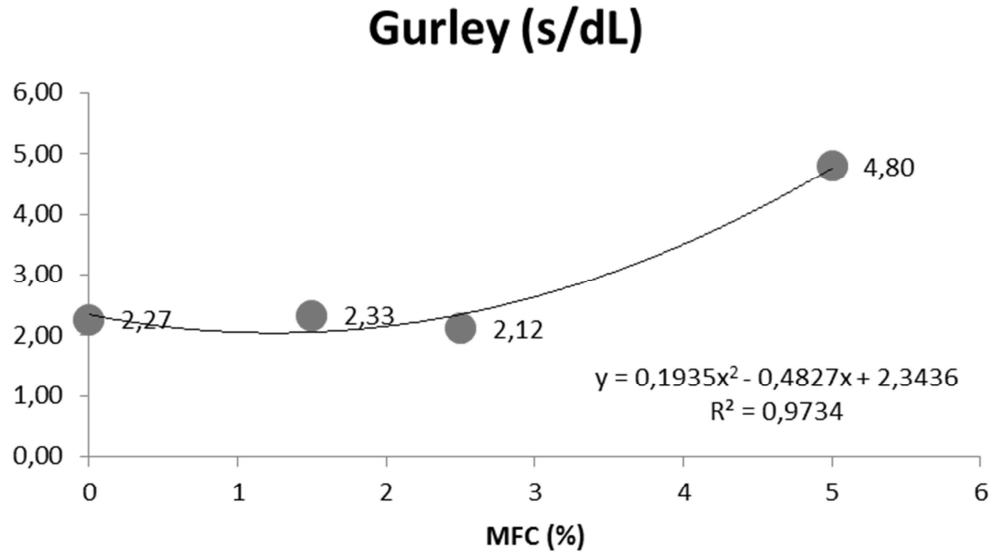

Figure 60

ºsr of the cellulosic pulp available in the market + MFC

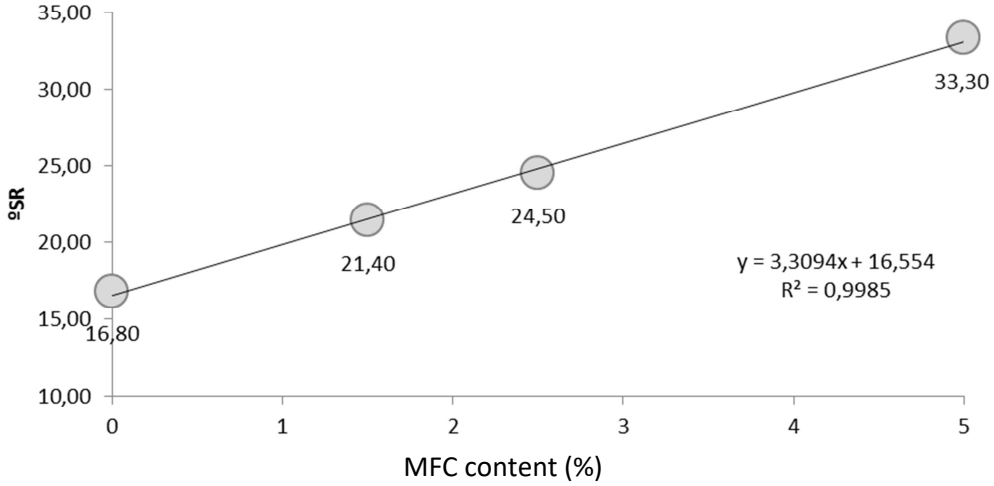

Figure 61

WRV of the cellulosic pulp available in the market + MFC

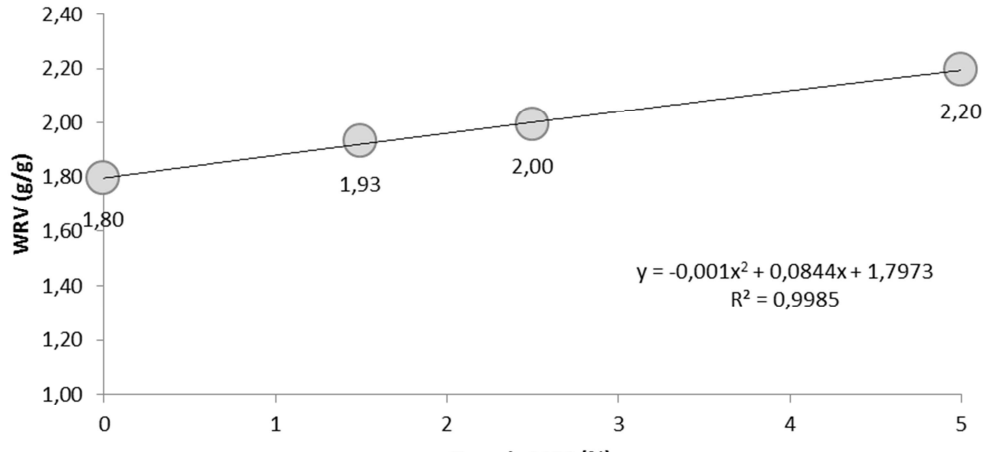

Figure 62

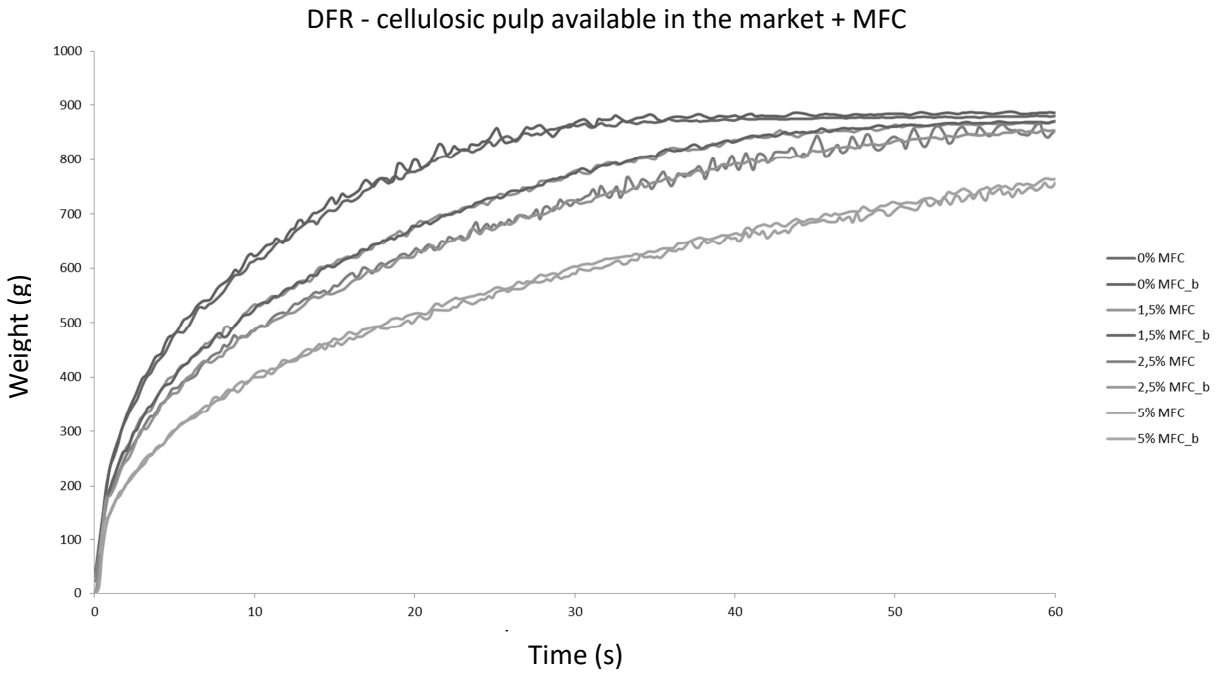

Figure 63

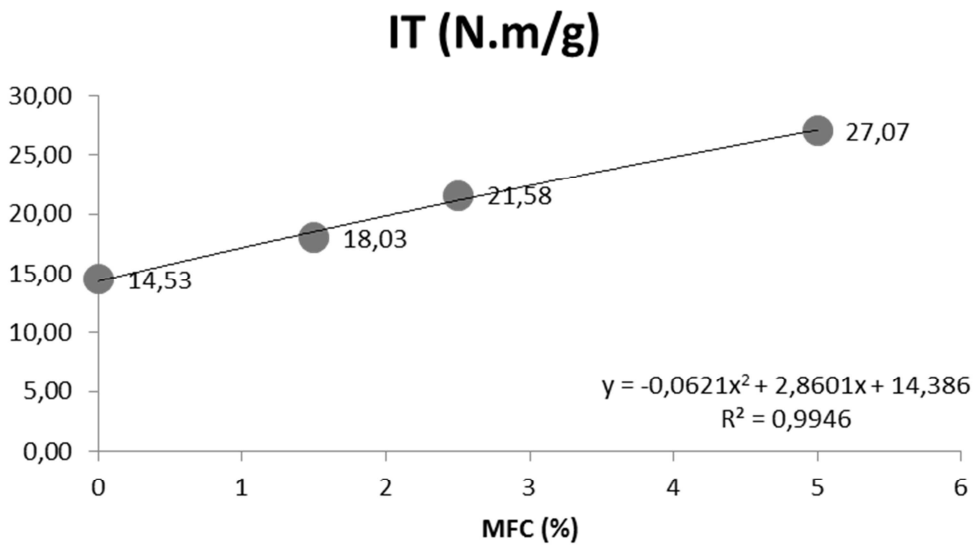

Figure 64

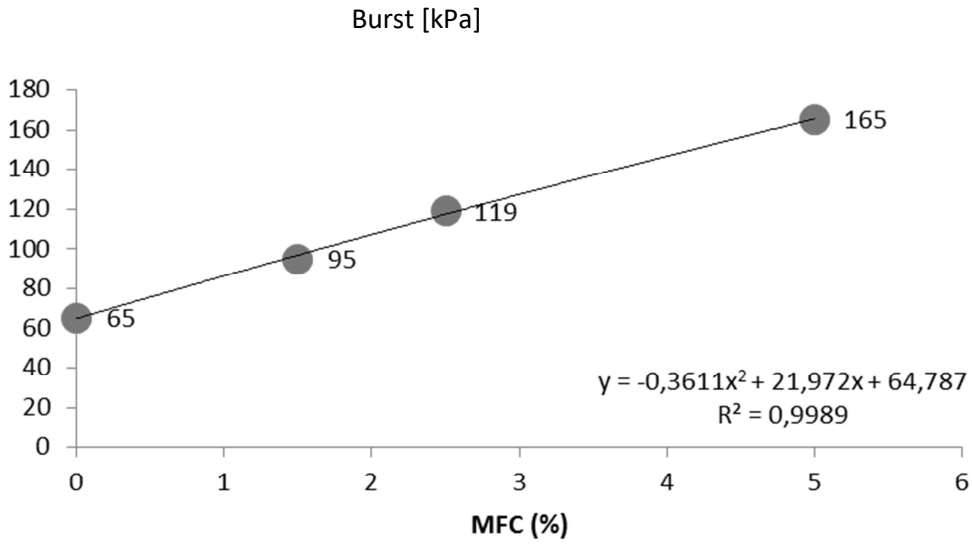

Figure 65

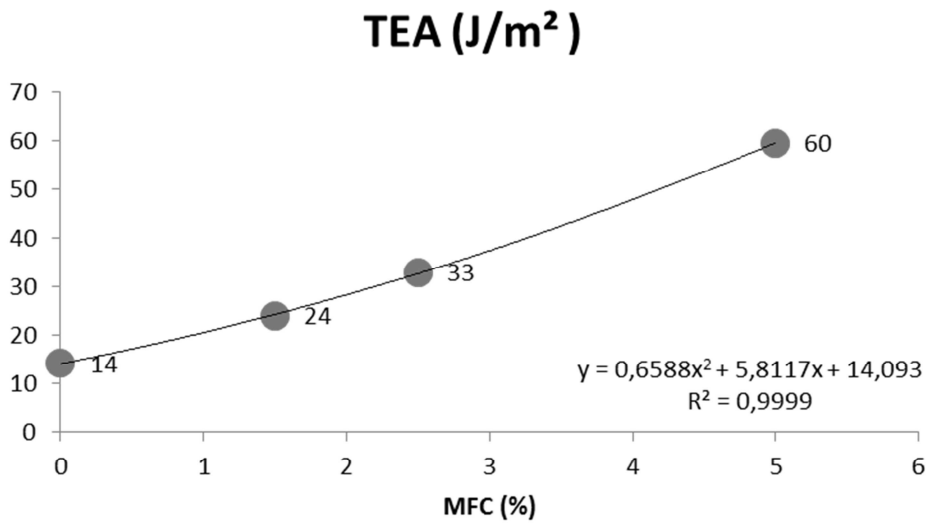

Figure 66

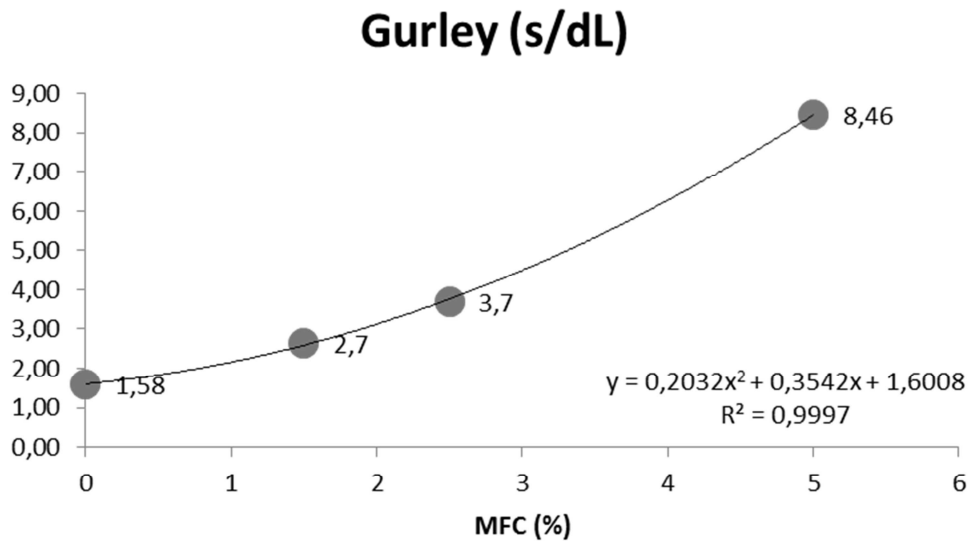

Figure 67

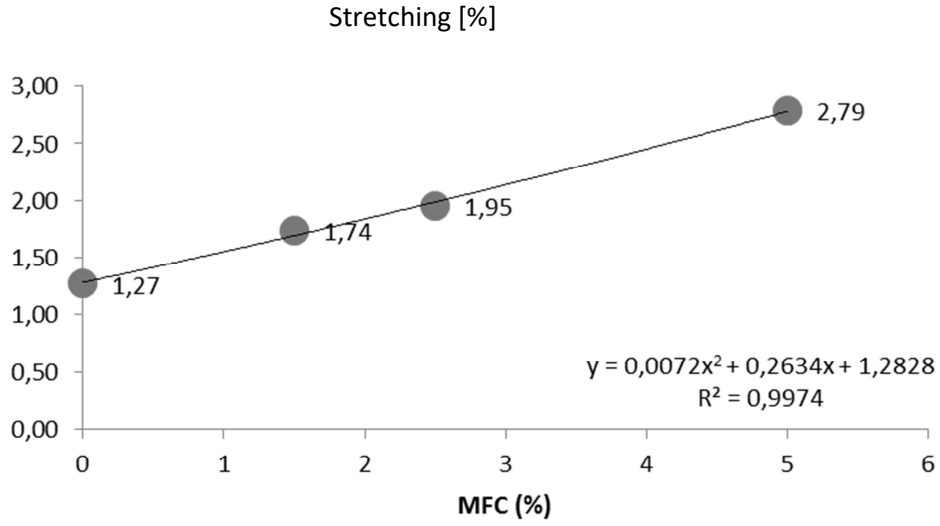

Figure 68

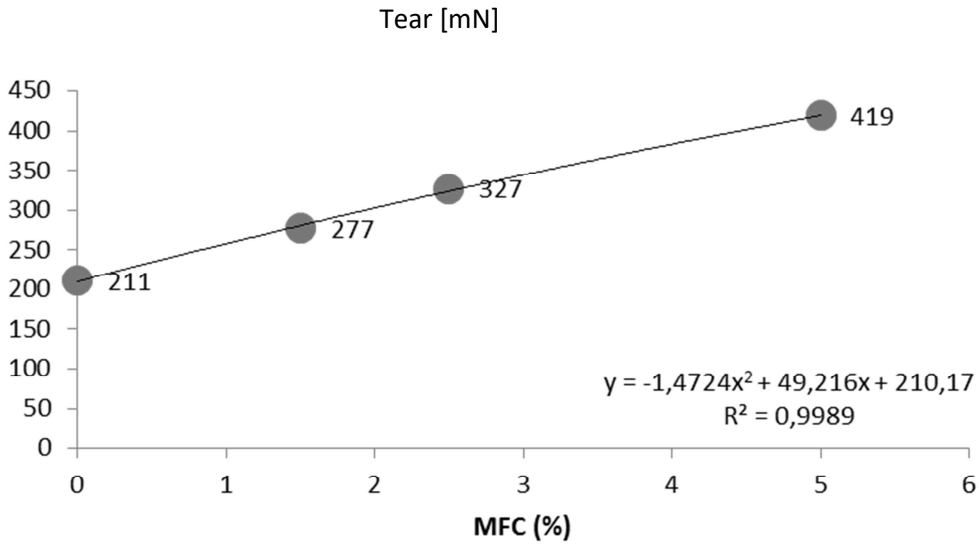

Figure 69

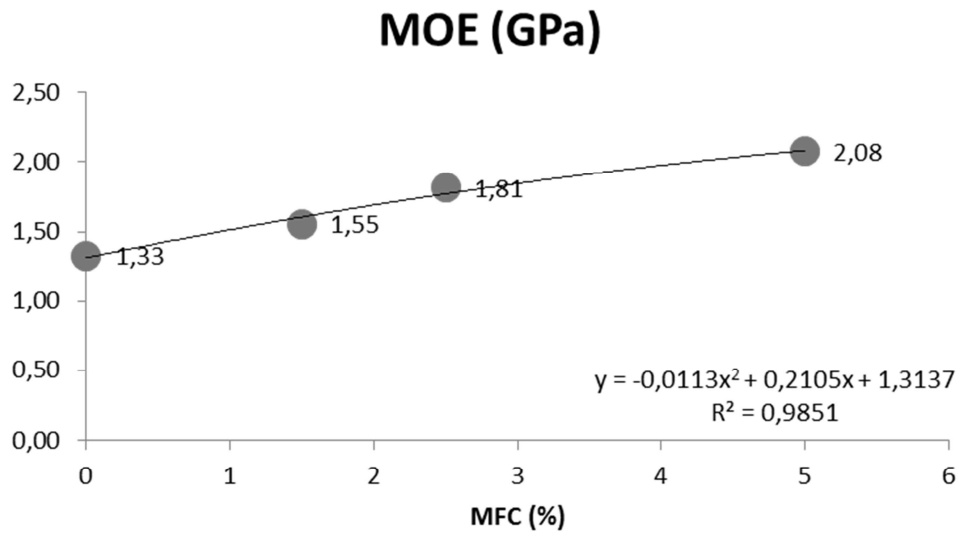

Figure 70