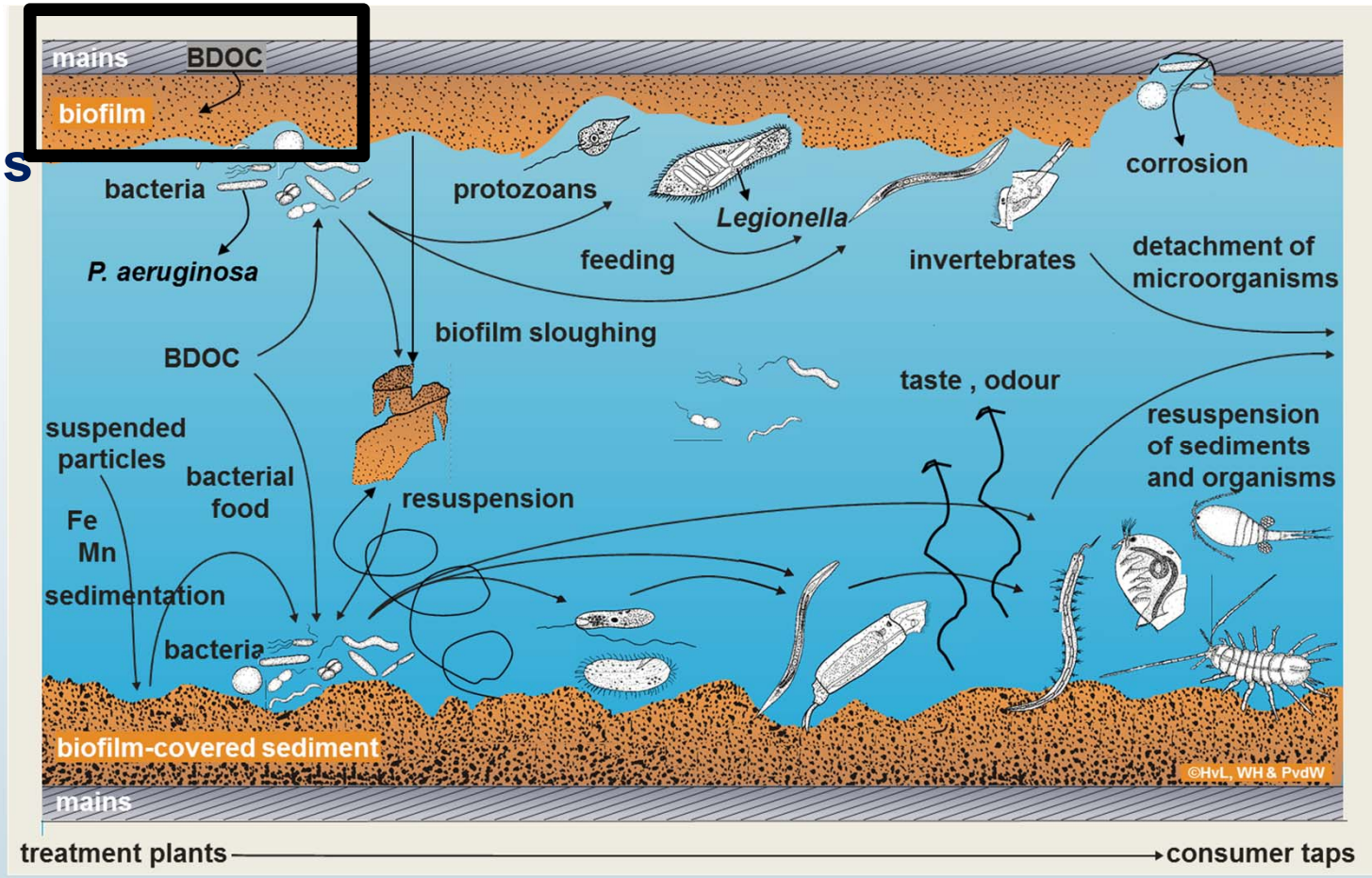
BTO

e/¤x#y#¥|x#¤ t'x§|t¦¤#|£#
x£{t£vxw#£§/< '{#y#/'t#
¢ |v§/y√§t t£w#¥¥/§'"£|¤'|v#
¥t'{/zx£¤

ct" ¦#¤t£#wx§#j |x¦¤x£?#_"w¢ |¦t Ux§x¤v{x£~/ 9#
^|¢ ux§¦fi#_xt§u"v{

W |¤'§|u" '|/£B¥§x¢ |¤x¤¥¡"¢ u|£z ¤fi¤'x¢

- **Drinking water Netherlands**
  - ***Produced from groundwater (2/3) and surface water (1/3)***
  - ***Intensive treatment***
  - ***Distribution without disinfectant residual***



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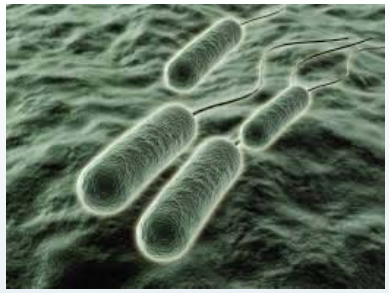

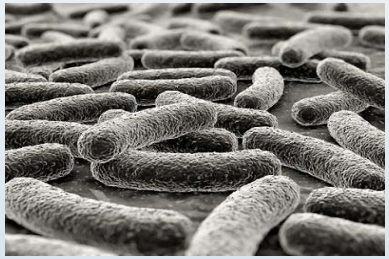

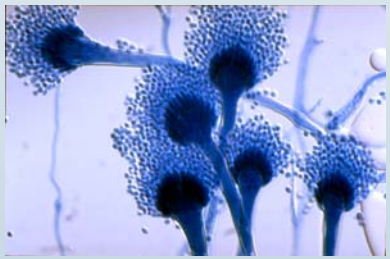

- **Determine the influence op pipe materials on:**
  - ***Total microbial growth***
  - ***Growth of opportunistic pathogens:***
    - ***Legionella pneumophila***
    - ***Pseudomonas aeruginosa***
    - ***Mycobacterium kansasii***
    - ***Aspergillus fumigatus***

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❑ Materials tested

- *Glass (negative control)*
- *PVC-P (positive control)*
- *Copper*
- *PE-Xb*
- *PE-Xc*
- *PVC-C*
- *PE-100*

❑ Test conditions

- **Incubation at 37°C**
- **Weekly drinking water replacement**
- **Samples taken after 8, 12 and 16 weeks for biomass (ATP) measurements**
- **After 16 weeks inoculation with *L. pneumophila***
- **Samples taken after 24, 28 and 32 weeks for biomass and *L. pneumophila***

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	Biomass production potential (pg ATP cm^{-2})	
	Average	St. dev.
Negative control (Glass)	*132*	*11*
Positive control (PVC-P)	*14,885*	*3,300*
Copper	*112*	*26*
PVC-C	*185*	*46*
PE-Xc	*794*	*69*
PE-Xb	*880*	*208*
PE-100	*2,204*	*207*

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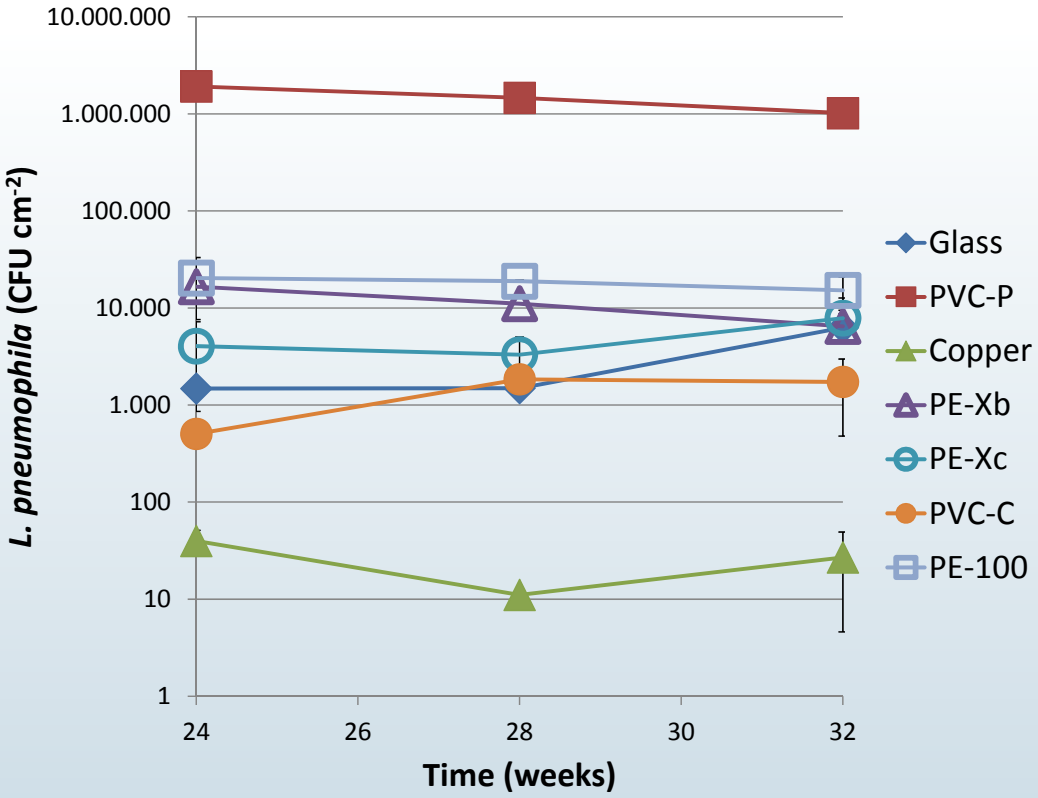
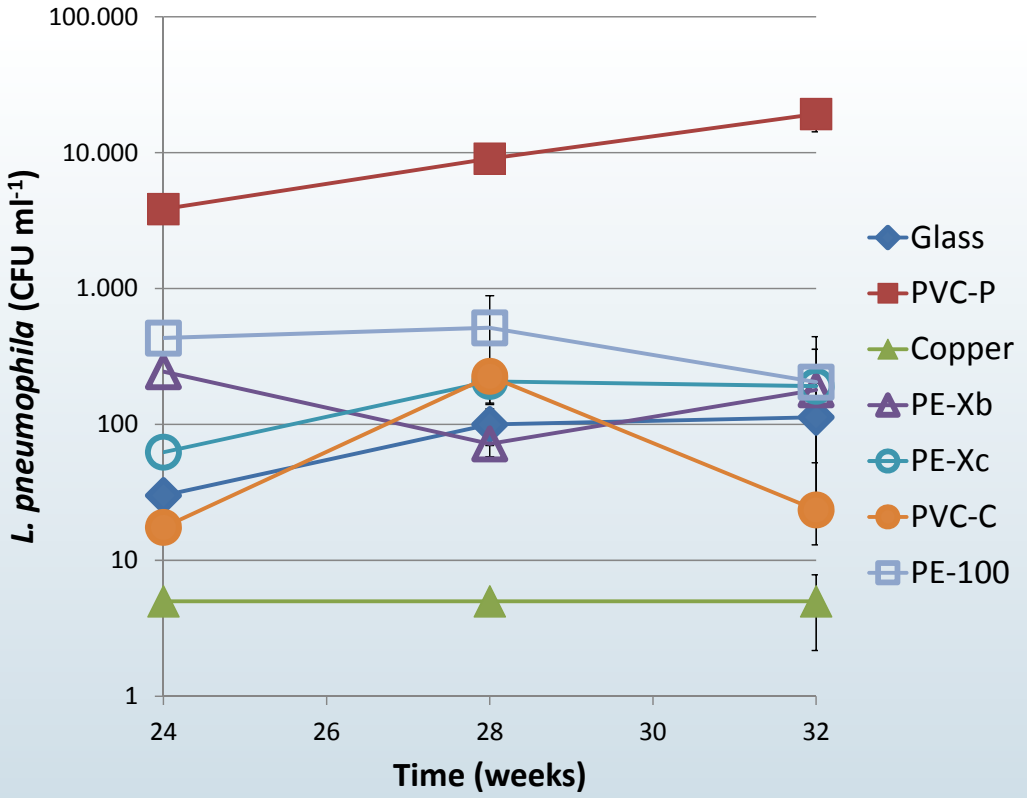

10.000.000
1.000.000
100.000
10.000
1.000
100
10
1
L. pneumophila (CFU cm-2)
24
26
28
30
32
Time (weeks)
Glass
PVC-P
Copper
PE-Xb
PE-Xc
PVC-C
PE-100

\£# t'x§


100.000
10.000
1.000
100
10
1
L. pneumophila (CFU ml-1)
24
26
28
30
32
Time (weeks)
Glass
PVC-P
Copper
PE-Xb
PE-Xc
PVC-C
PE-100

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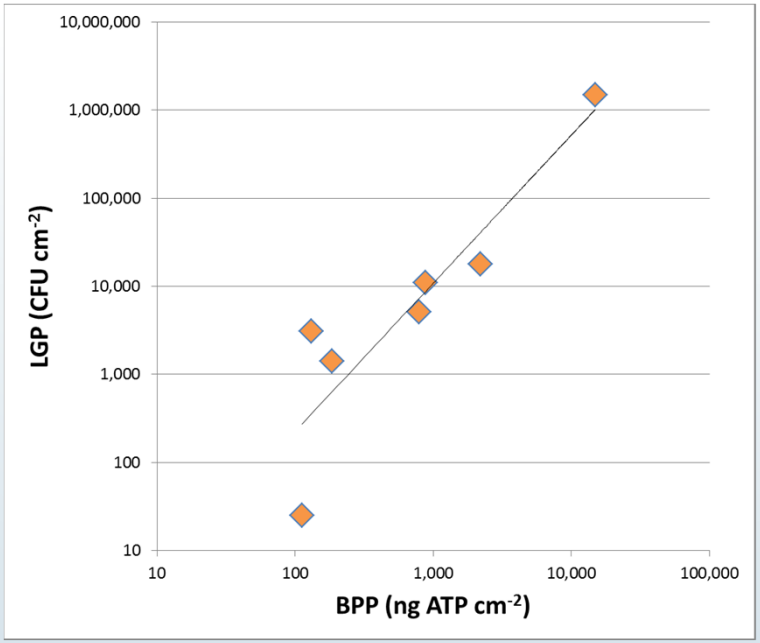
	BPP (pg ATP cm^{-2})	LGP (CFU cm^{-2})
Negative control (Glass)	*132*	*3.1 × 10^3*
Positive control (PVC-P)	*14,885*	*1.5 × 10^6*
Copper	*112*	*2.5 × 10^1*
PVC-C	*185*	*1.4 × 10^3*
PE-Xc	*794*	*5.1 × 10^3*
PE-Xb	*880*	*1.1 × 10^4*
PE-100	*2,204*	*1.8 × 10^4*



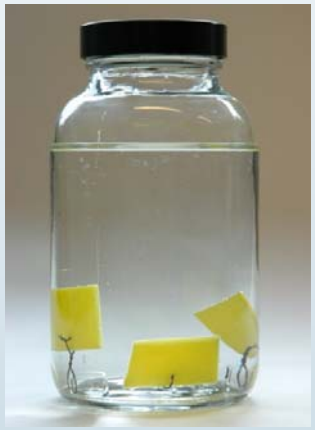
R^2=0.81

Y=1.7x - 1.0

Z §/< '{#/'{x§#/§ztt£ |¤¢ ¤#/£#¥ |¥x#¢ t'x§|t ¡¤

❑ Materials tested

- ***Glass (negative control)***
- ***PVC-P (positive control)***
- ***Copper***
- ***Stainless steel***
- ***PVC-C***
- ***PE-Xa***
- ***PE-Xc***
- ***PVC-C***
- ***PE-100***
- ***PE-40***
- ***EPDM***



❑ Test conditions

- **Incubation at 37°C**
- **Weekly drinking water replacement**
- **Inoculation with organisms on day 0 and day 126**
- **Samples taken after 8, 12, 16, 24, 28 and 32 weeks for measurements of biomass and each organism (*P. aeruginosa*, *M. kansasii or A. fumigatus*)**

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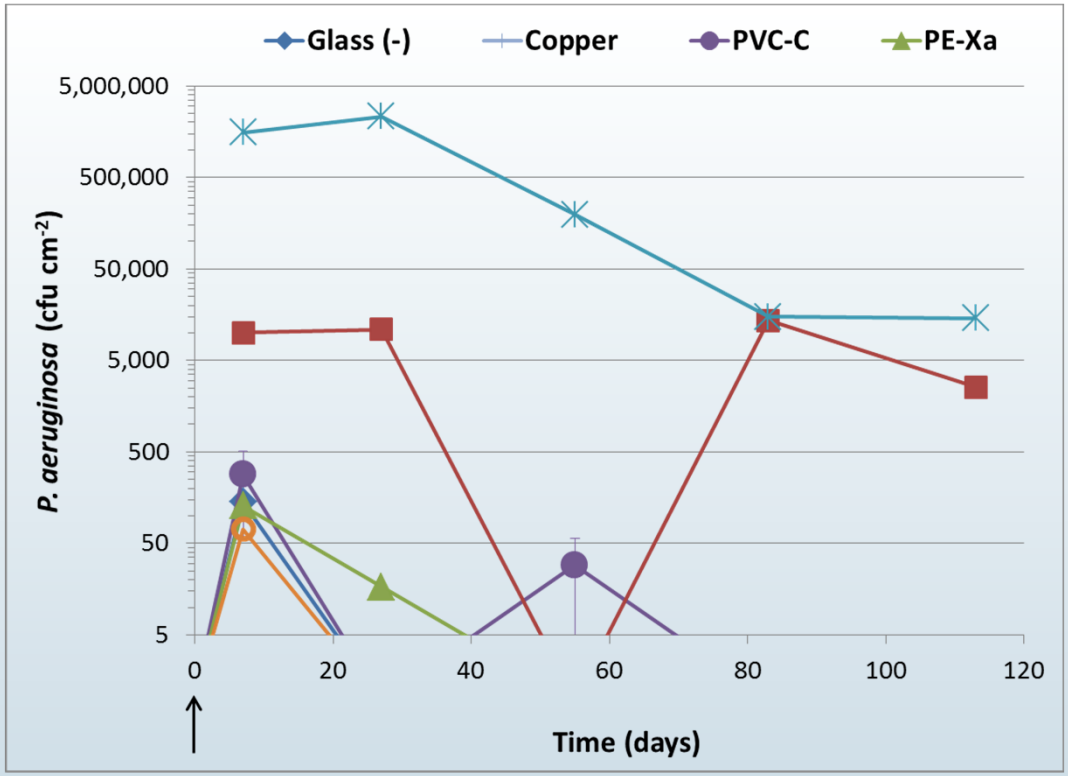
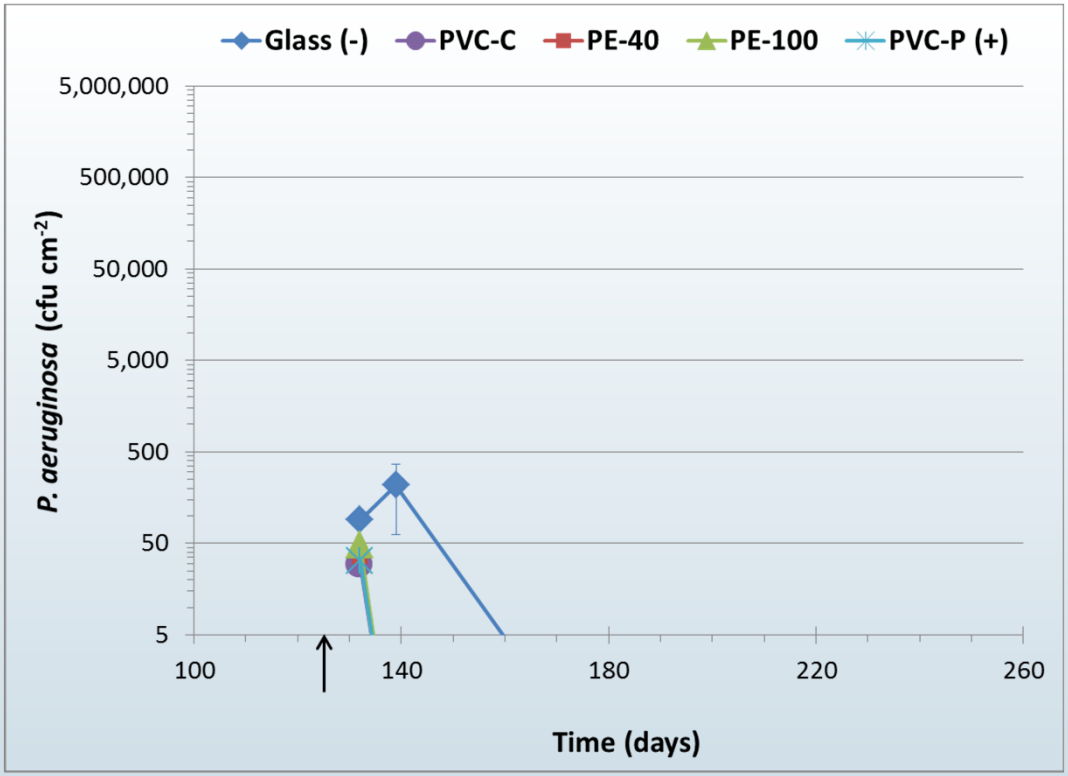

Glass (-)
Copper
PVC-C
PE-Xa
5,000,000
500,000
50,000
5,000
500
50
5
P. aeruginosa (cfu cm-2)
0
20
40
60
80
100
120
Time (days)


Glass (-)
PVC-C
PE-40
PE-100
PVC-P (+)
5,000,000
500,000
50,000
5,000
500
50
5
P. aeruginosa (cfu cm-2)
100
140
180
220
260
Time (days)

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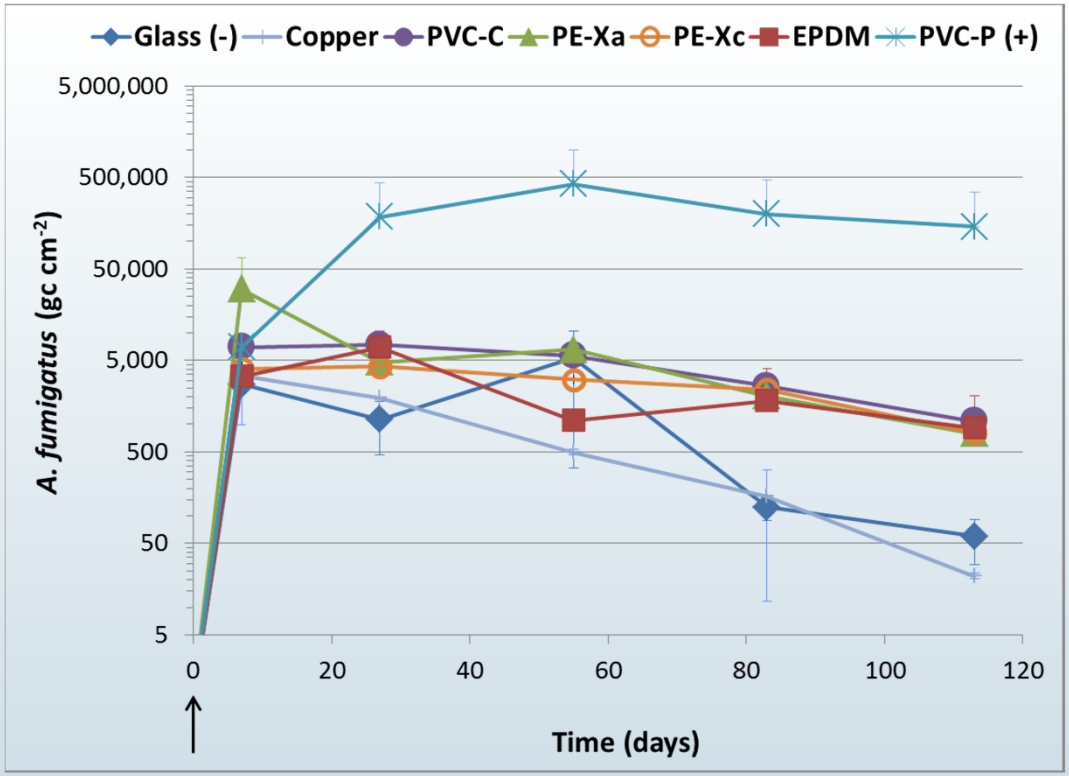
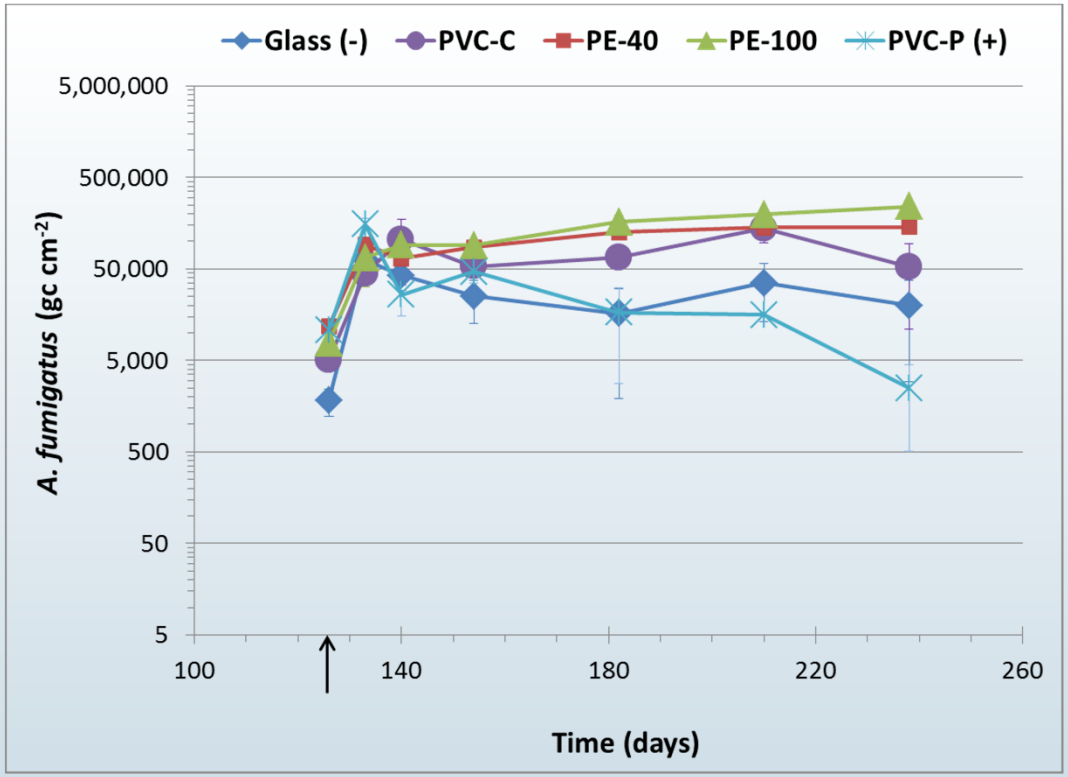

Glass (-)
Copper
PVC-C
PE-Xa
PE-Xc
EPDM
PVC-P (+)
5,000,000
500,000
50,000
5,000
500
50
5
A. fumigatus (gc cm-2)
0
20
40
60
80
100
120
Time (days)


Glass (-)
PVC-C
PE-40
PE-100
PVC-P (+)
5,000,000
500,000
50,000
5,000
500
50
5
A. fumigatus (gc cm-2)
100
140
180
220
260
Time (days)

Z §/< '{ #¥/'x£'|t ¡¤#¥t'{/zx£¤#;vy‟ /§#zvv¢ @E<

Material	*P. aeruginosa* Day 0	Day 126
Glass (-)	*0.4*	*1.3*
PVC-P (+)	*1.7 × 10^5*	*0.9*
Copper	*< 0.1*	*ND*
SS	*0.3*	*ND*
PVC-C	*1.6*	*2.0*
PE-Xa	*0.9*	*ND*
PE-Xc	*0.2*	*ND*
PE-100	*0.3*	*2.0*
PE-40	*0.3*	*1.6*
EPDM	*2.2×10^3*	*ND*

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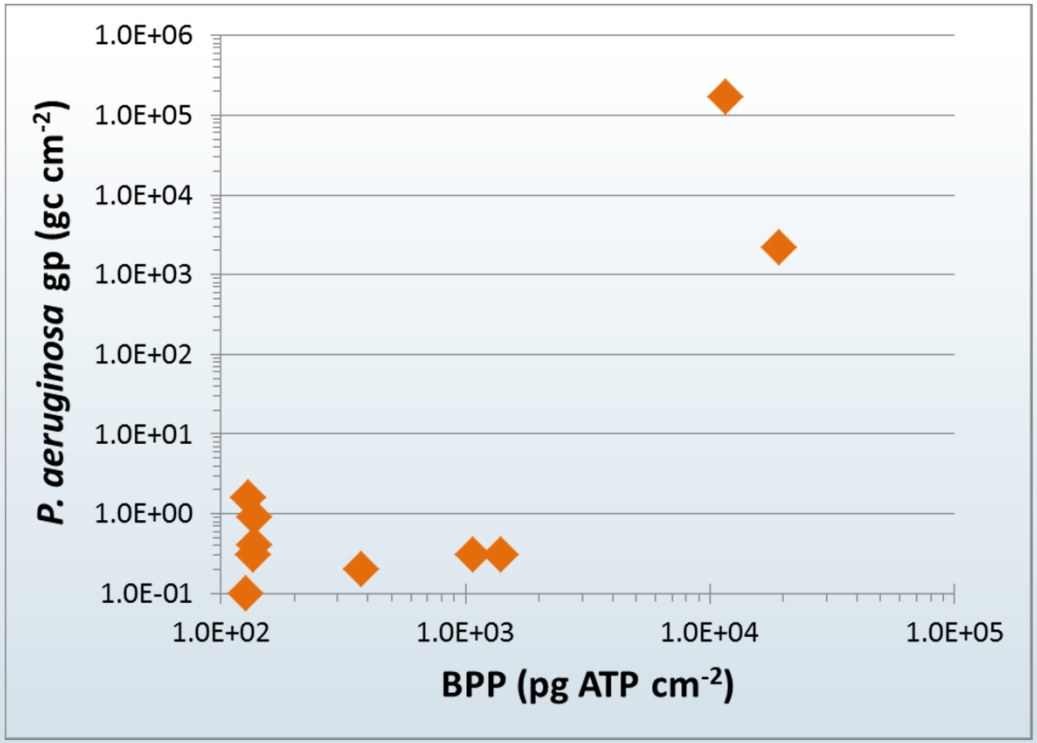
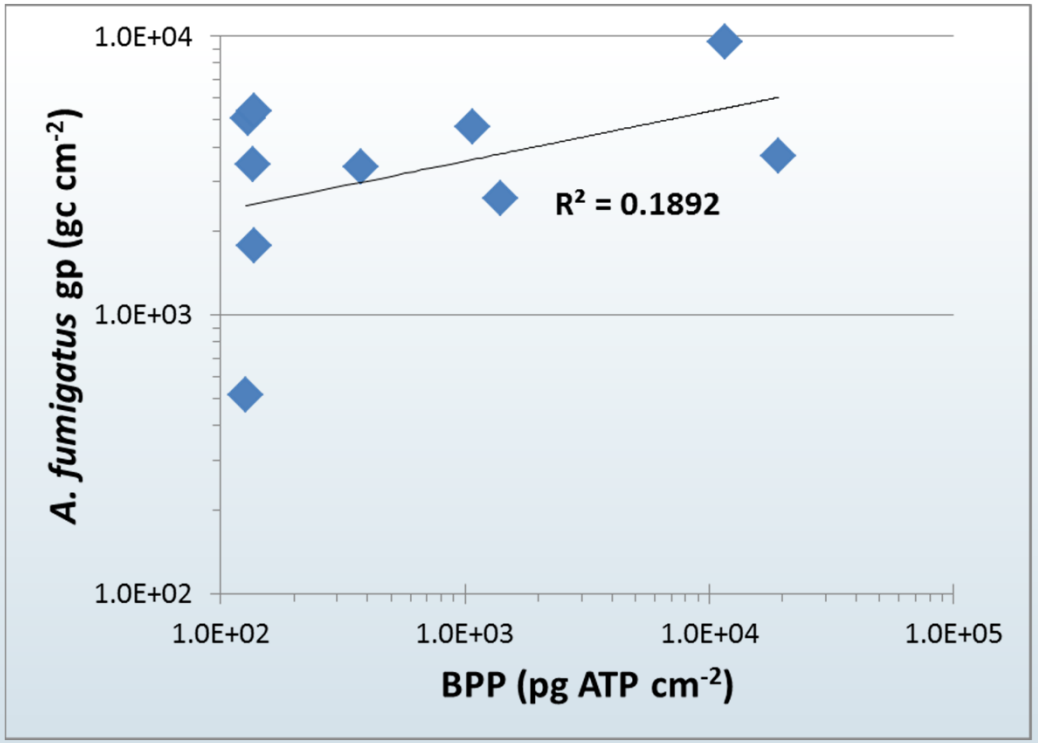

1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
1.0E-01
P. aeruginosa gp (gc cm-2)
1.0E+02
1.0E+03
1.0E+04
1.0E+05
BPP (pg ATP cm-2)


1.0E+04
1.0E+03
1.0E+02
A. fumigatus gp (gc cm-2)
R² = 0.1892
1.0E+02
1.0E+03
1.0E+04
1.0E+05
BPP (pg ATP cm-2)

Conclusions

- PE-based pipe materials and PVC-P can enhance growth of *L. pneumophila*
- Tested pipe materials do not increase risk for growth of *P. aeruginosa*
- Growth of *A. fumigatus* can slightly be increased by the tested pipe materials compared to glass
- PE-based pipe materials can enhance growth of *M. kansasii*
- Based on the precautionary principle, use of PE-based materials, EPDM and PVC-P should be avoided as much as possible in drinking water installations and distribution systems

g{t£~¤'/M

]/|£'#Bx¤xt§v{#¥§/z§t¢ #w§|£~|£z < t'x§#

v/¢ ¥t£|x¤#|£#{x#a x'{x§¡t£w¤

' |v§/u|t¡ffj t'x§#d "t¡|'fi#£w#[xt¡'{?#^j e

_tu/§t'/§fi/y# |v§/u|/¡/zfi?#^j e

¥t"¡A<t£Awx§A |x¡x£S~< §< t'x§A£¡