

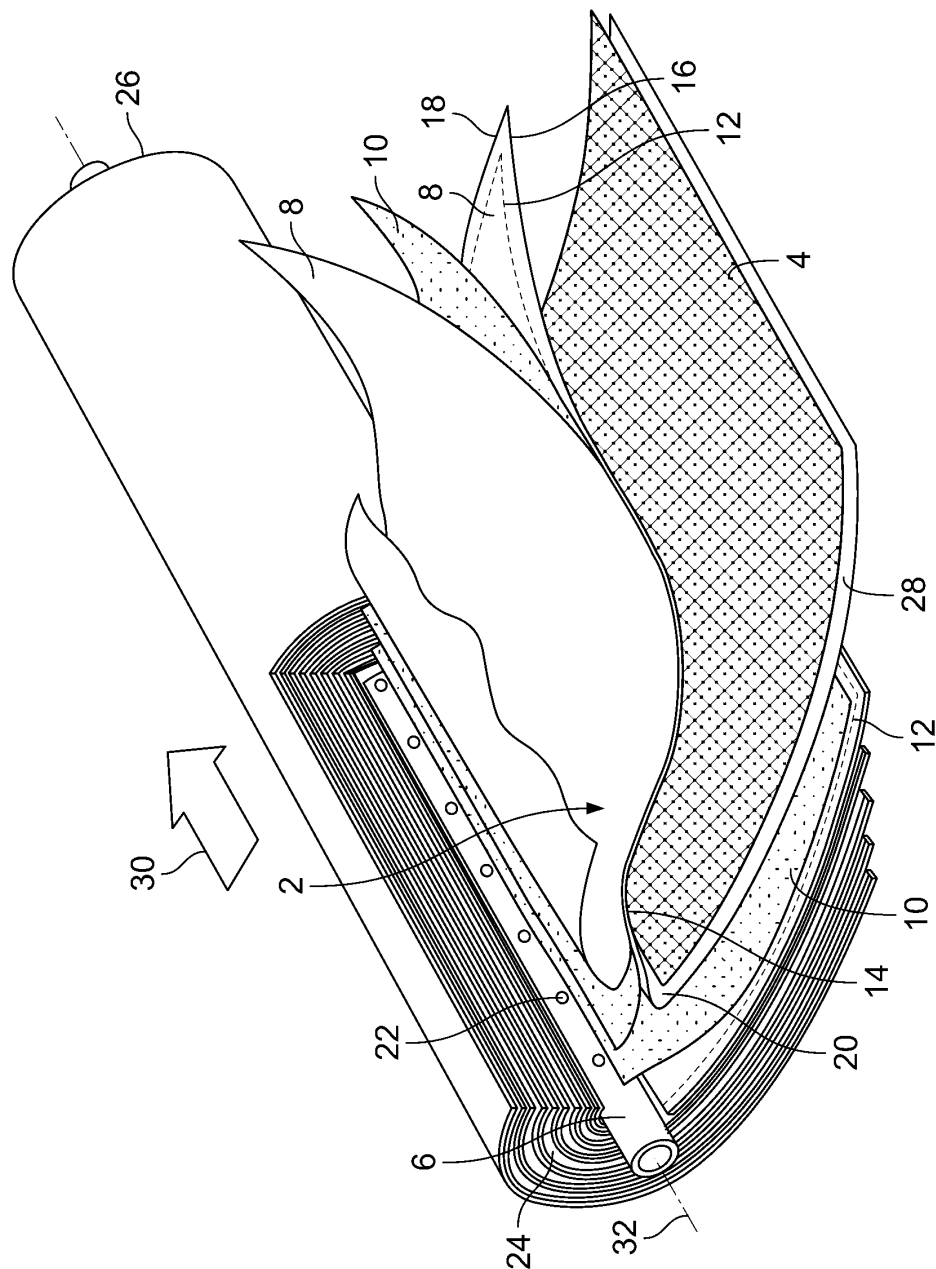
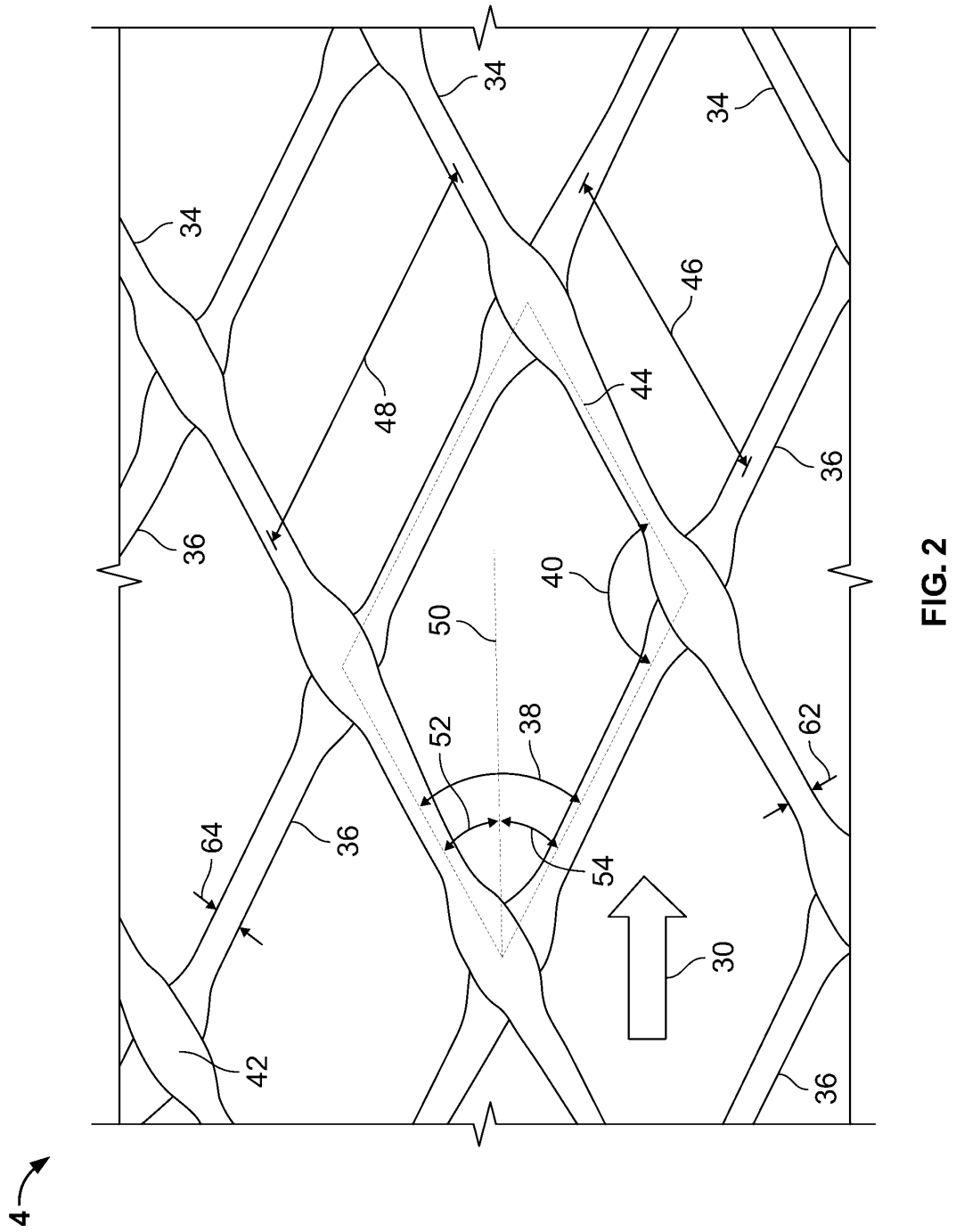


FIG. 1



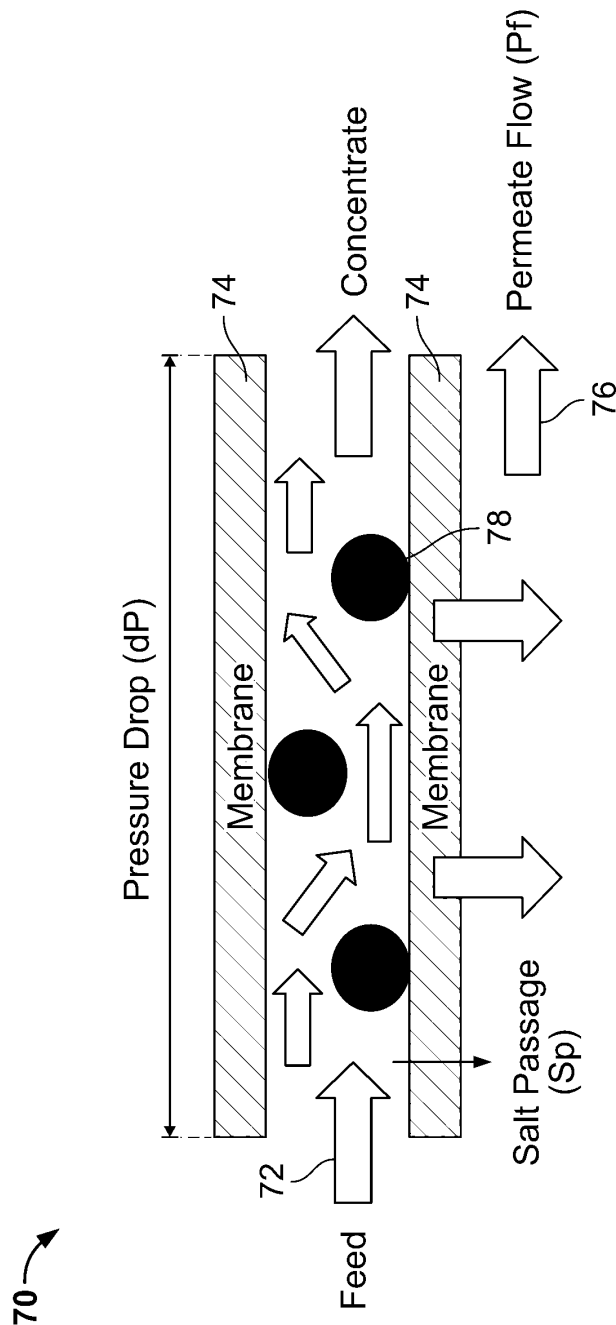


FIG. 3

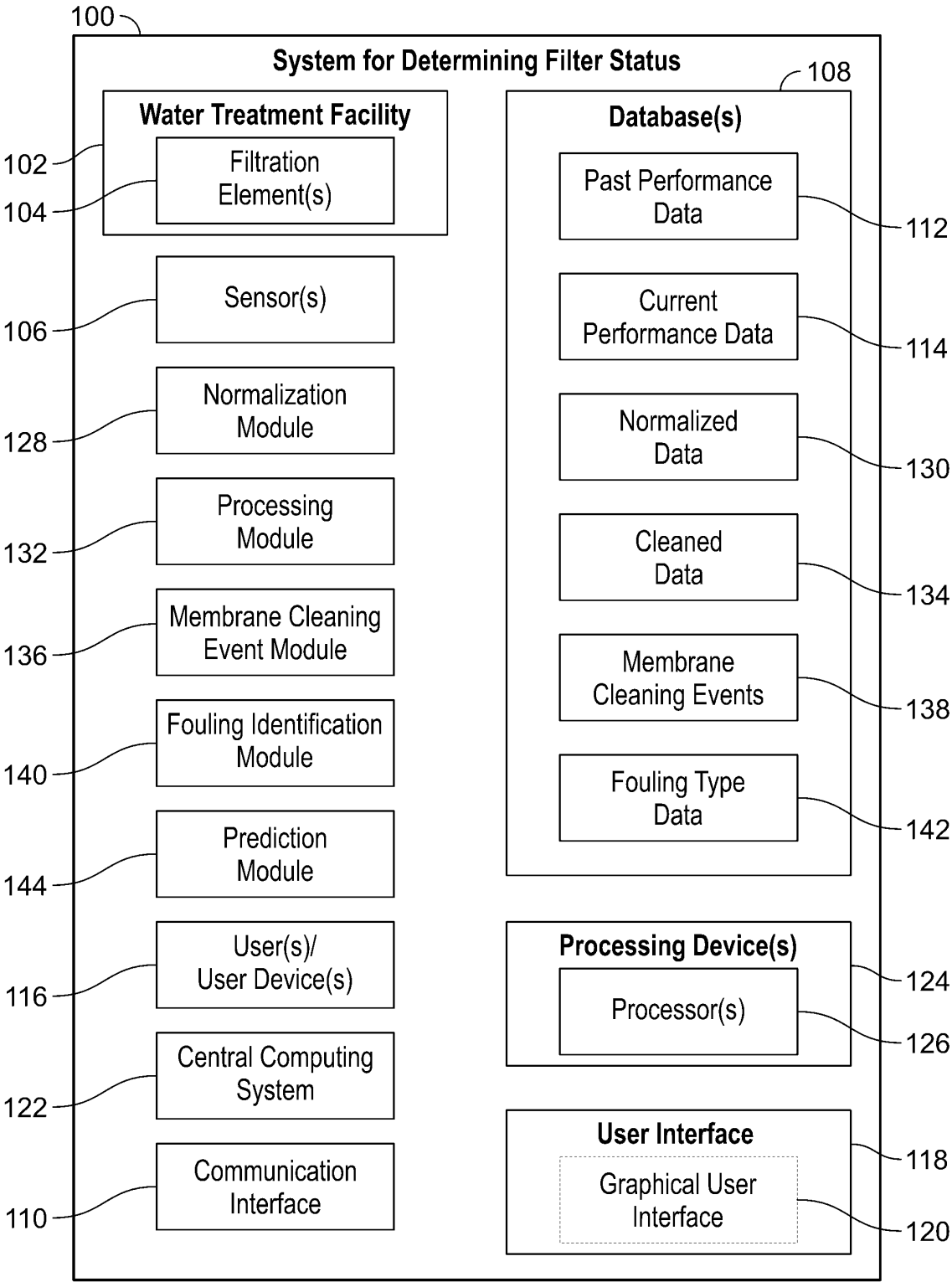


FIG. 4

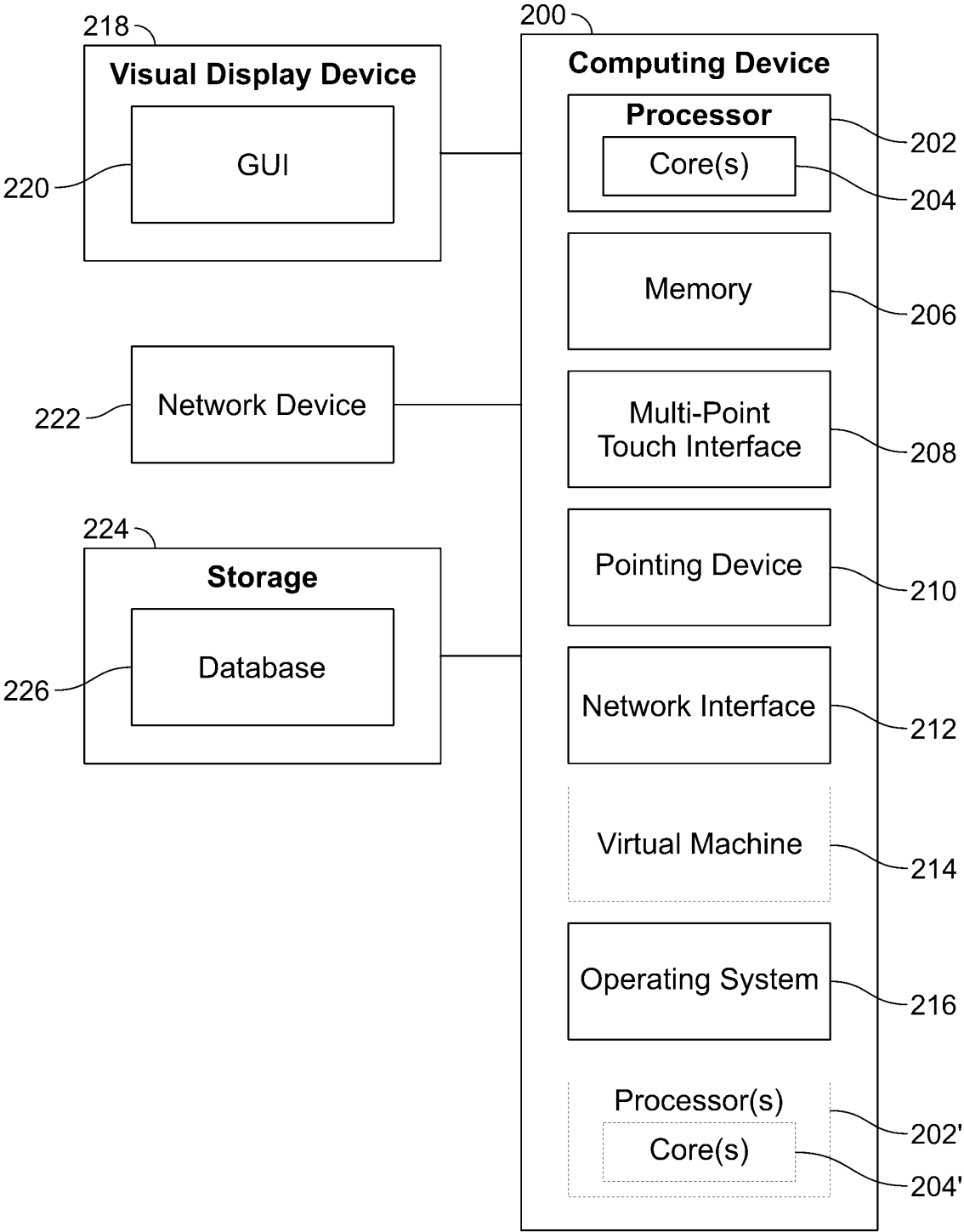


FIG. 5

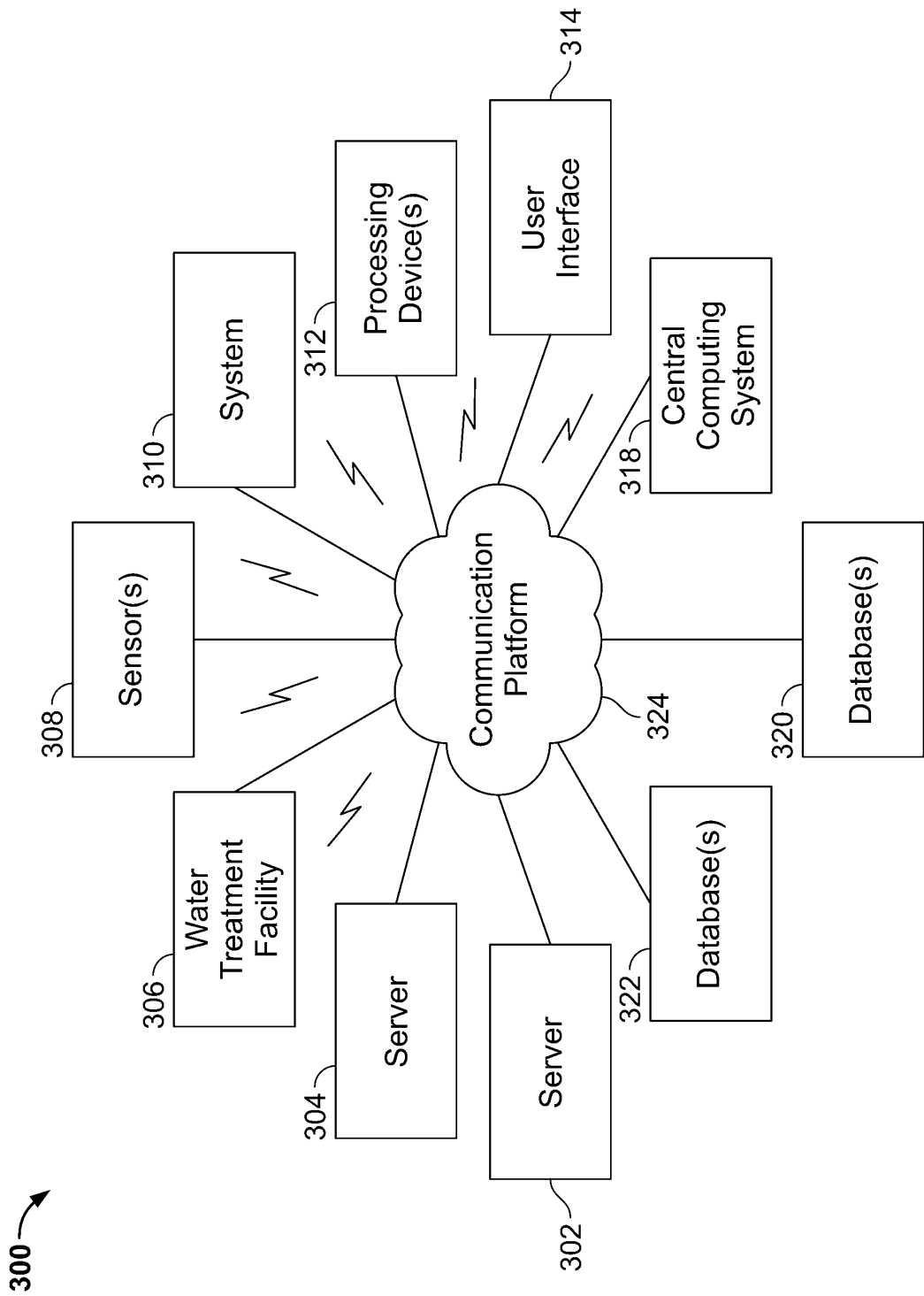


FIG. 6

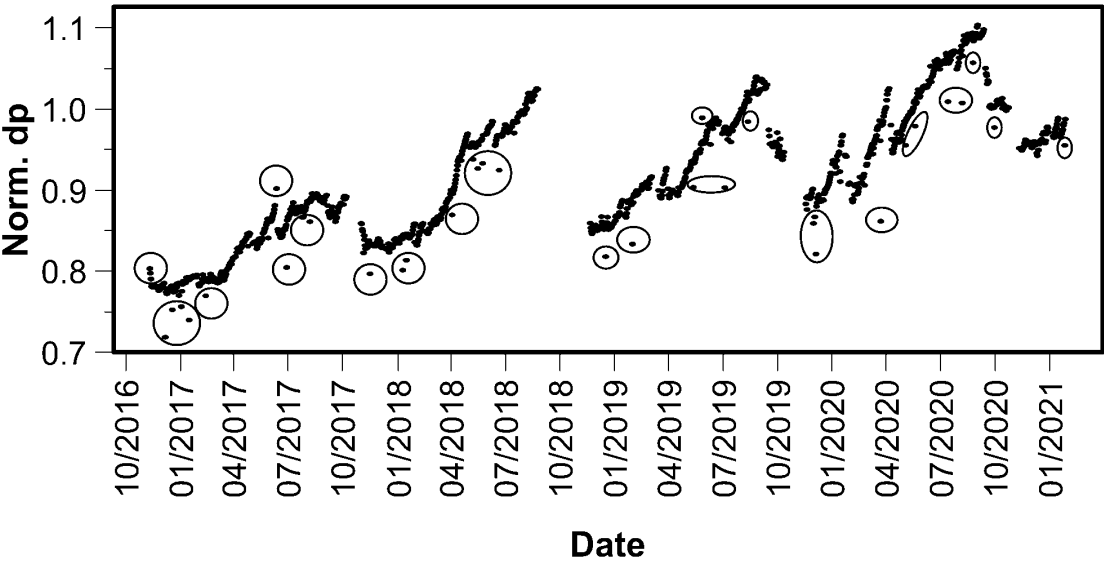


FIG. 7A

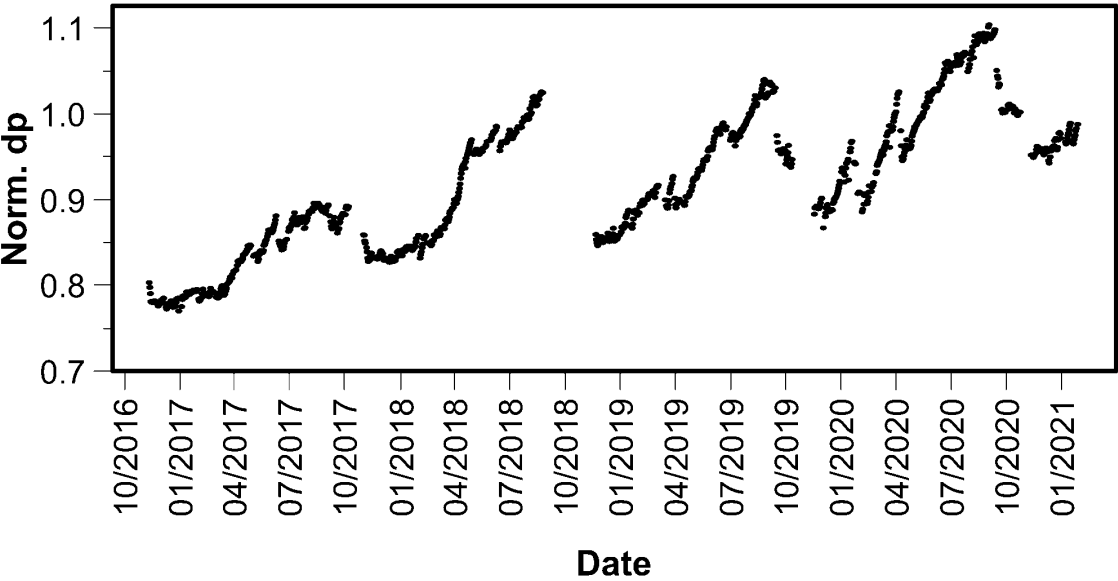


FIG. 7B

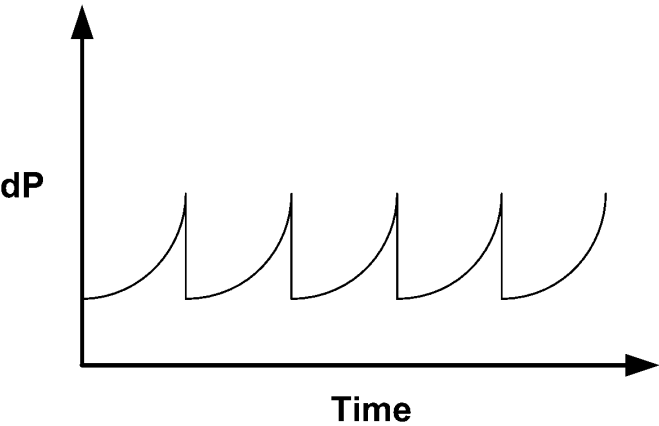


FIG. 8A

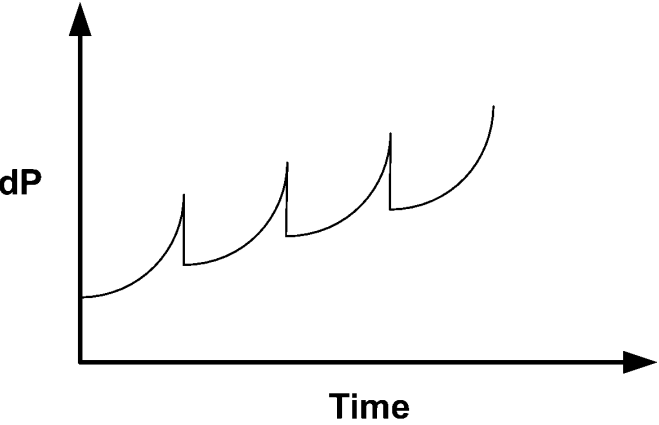


FIG. 8B

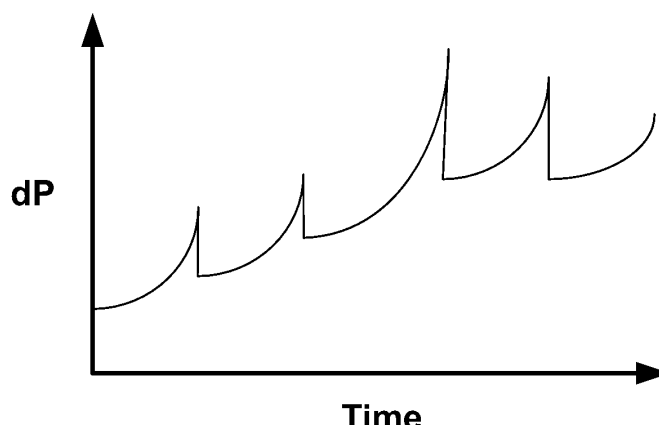


FIG. 8C

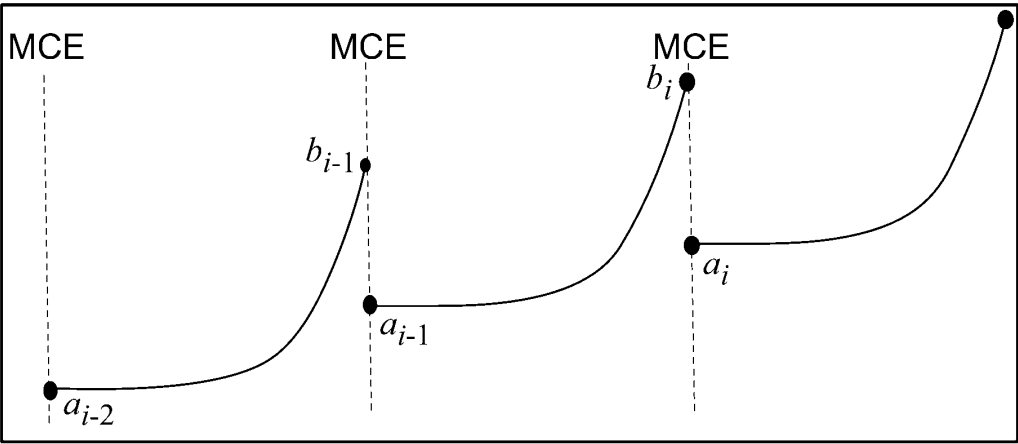


FIG. 9

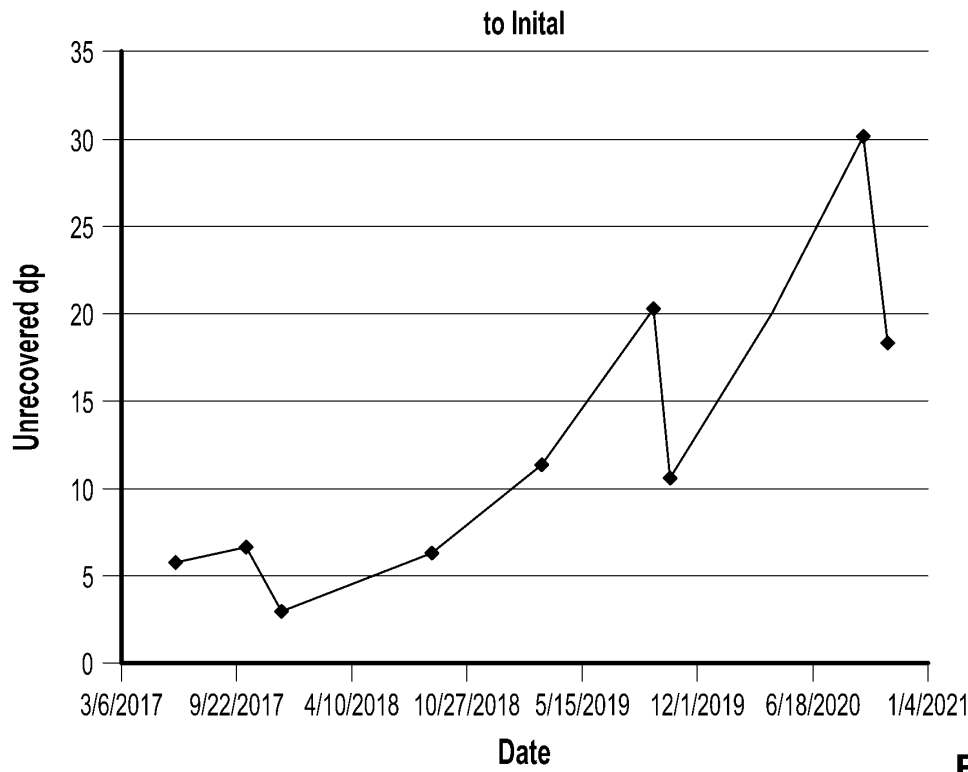


FIG. 10

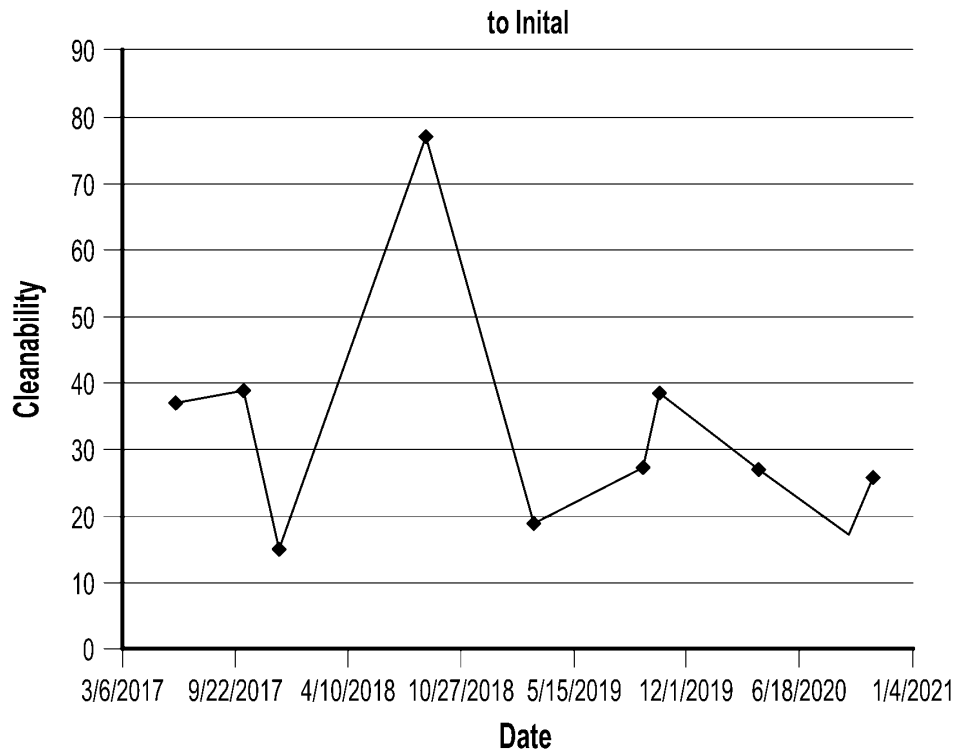


FIG. 11

Fouling type	Element Position	Normalized pressure drop (dP)		Normalized Permeate Flow (Pf)		Normalized Salt Passage (Sp)	
		Fitting	Slope vs time	Fitting	Slope vs time	Fitting	Slope vs time
No fouling	Any	Linear	~0	Linear	~0	Linear	~0
Biofouling	Lead	Non-linear	Positive	Non-linear*	Negative*	Non-linear*	Positive*
Organic fouling	Any	Linear*	~0*	Non-linear	Negative	Non-linear*	Negative*
Particulate fouling	Lead	Linear	Positive ^a	Linear*	Negative ^a	Linear*	Positive ^a
Scaling	Tail	Linear	Positive	Linear*	Negative*	Linear*	Positive*
Chemical degradation	Any	Linear*	~0*	Linear	Positive	Linear	Positive
Physical integrity problems	Lead/Tail	Linear*	~0*	Linear	Positive ^a	Linear	Positive ^a

*Optional parameters to be used on fouling determination

^aRapid change (>5% change in <24-hour operational period)

FIG. 12A

Operation Step	Specific Norm. TMP_F		TMP based Cleanability (%)	Duration	Frequency	Cleaning Chemicals
	Fitting	Slope vs t				
Filtration	Linear	~0	-	<60 min	-	No
BW (Backwash)	Linear	Positive	<30%	<300 s	<59 min	Yes, low concentration
CEC (Chemical Enhanced Cleaning)	Non-Linear	Positive	30 - 98 %	1 - 60 min	1 - 29 day	Yes, mid concentration
CIP (Cleaning In Place)	Non-Linear	Positive	>98%	>1 hours	>1 months	Yes, high concentration

FIG. 12B

Problem	Specific Norm. TMP_F	Specific Norm. TMP at BW: TMP_BW		Specific Norm. TMP at CEC: TMP_CEC		CEC Cleanability (%)	Membrane filtrate turbidity *
		Fitting	Slope vs. time	Fitting	Slope vs. time		
No fouling	Constant	Constant	0	Constant	0	~100%	<1 NTU
Particle, cake formation fouling	Linear	Linear	Close to 0	linear	Close to 0	60~95%	<1 NTU
Organic, biofouling	Linear or non-linear	Linear or Non-linear	Positive	Linear or Non-linear (oxidant/caustic CEC)	Positive	<60%	<1 NTU
Inorganic fouling/ scaling	Linear or non-linear	Linear or Non-linear	Positive	Linear or Non-linear (acid CEC)	Positive	<60%	<1 NTU
Chemical degradation	-	-	-	-	-	-	Positive, gradual change
Physical integrity	-	-	-	-	-	-	Positive rapid change

FIG. 12C

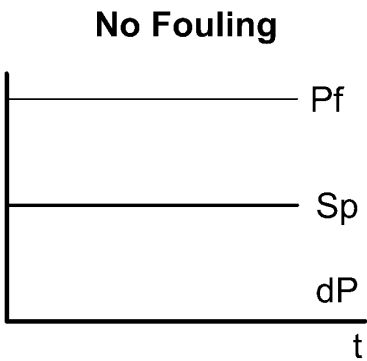


FIG. 13A

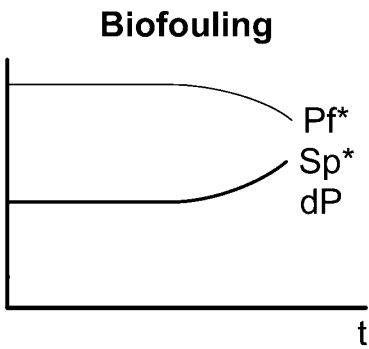


FIG. 13B

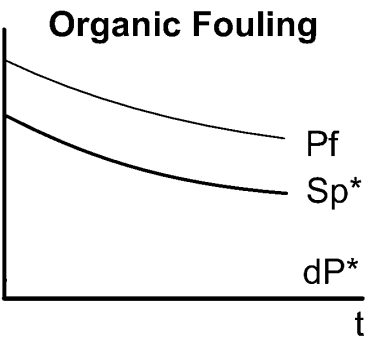


FIG. 13C

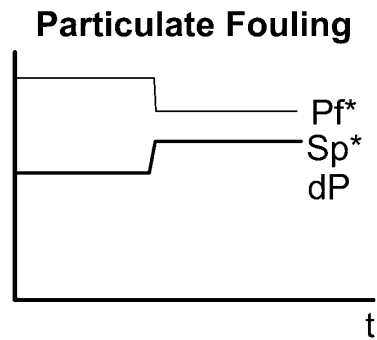


FIG. 13D

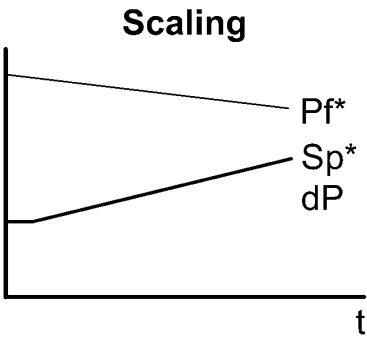


FIG. 13E

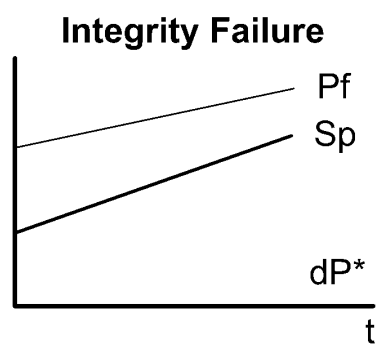


FIG. 13F

*Optional parameter to be used on fouling determination

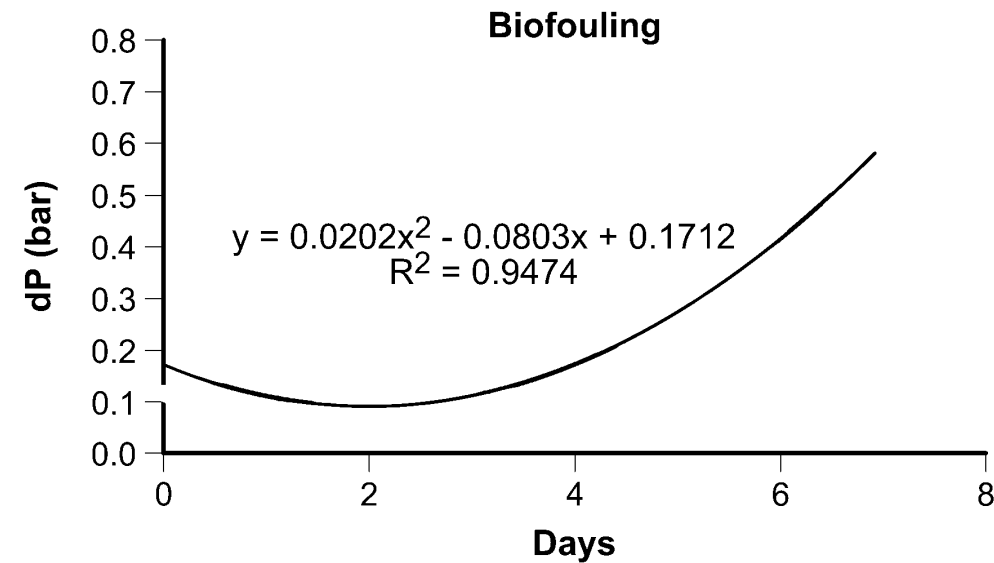


FIG. 14

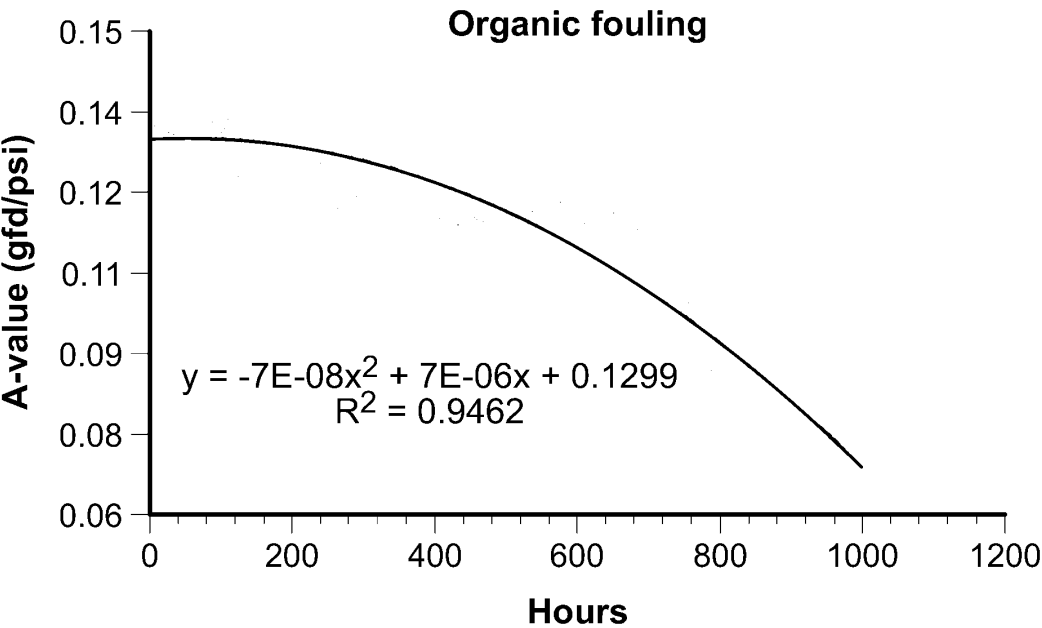


FIG. 15

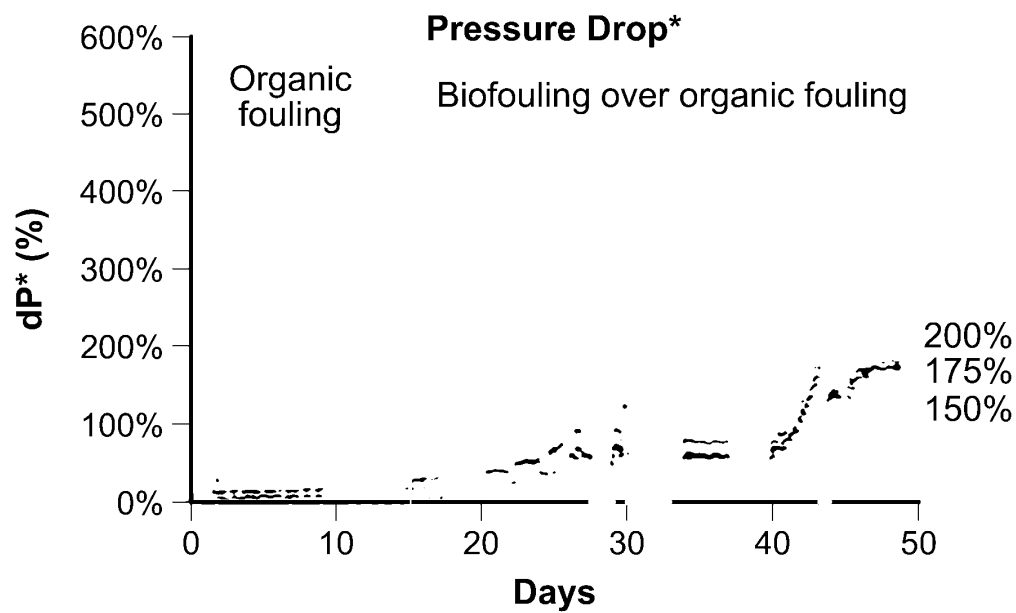


FIG. 16

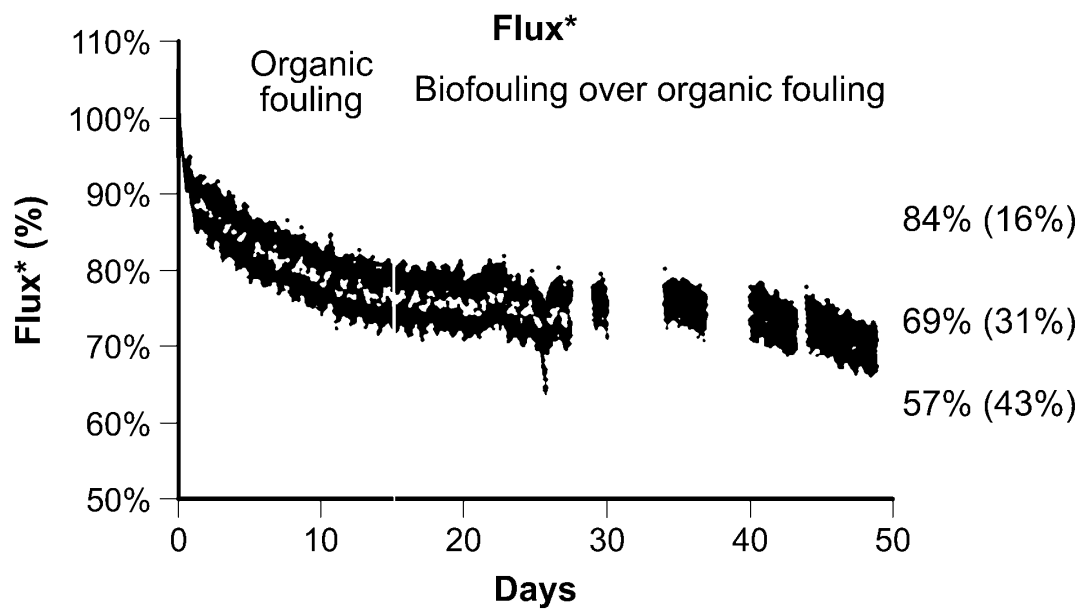


FIG. 17

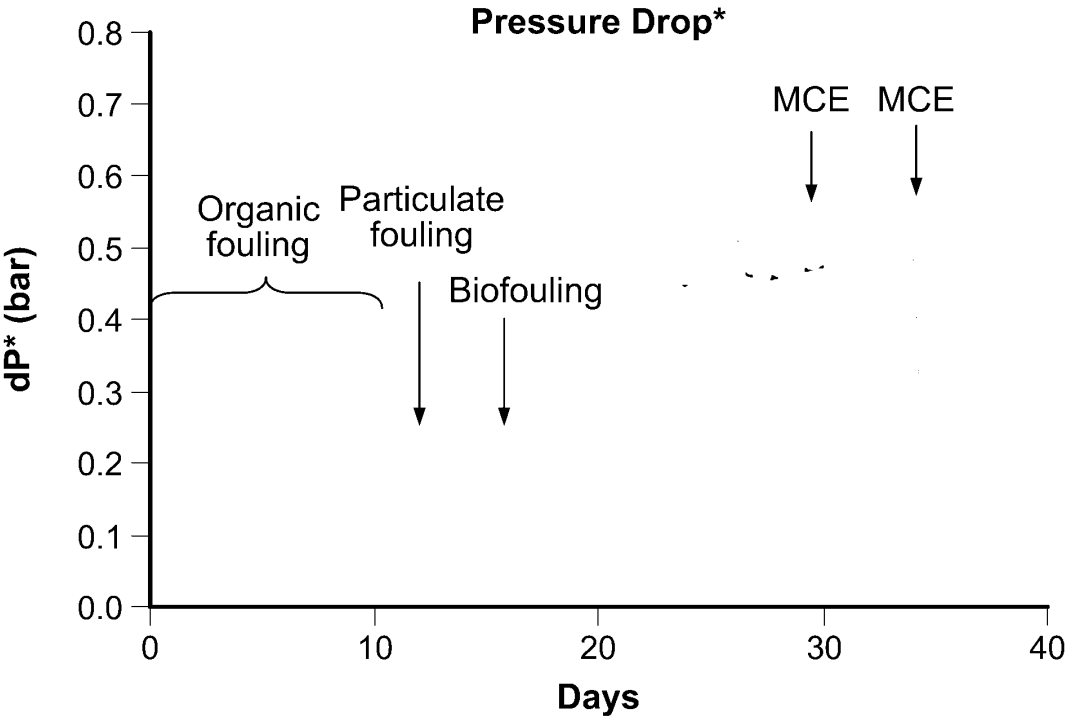


FIG. 18

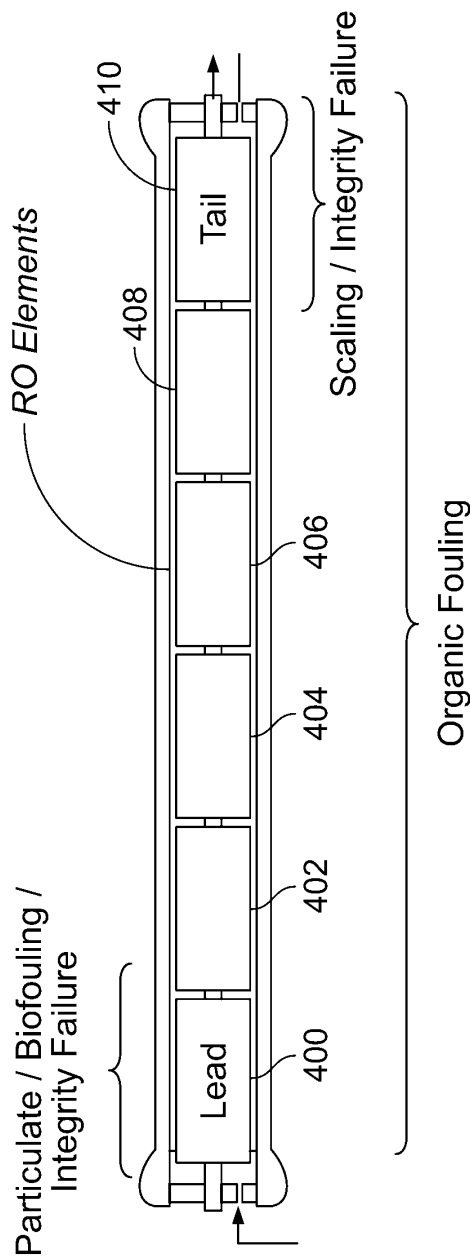


FIG. 19

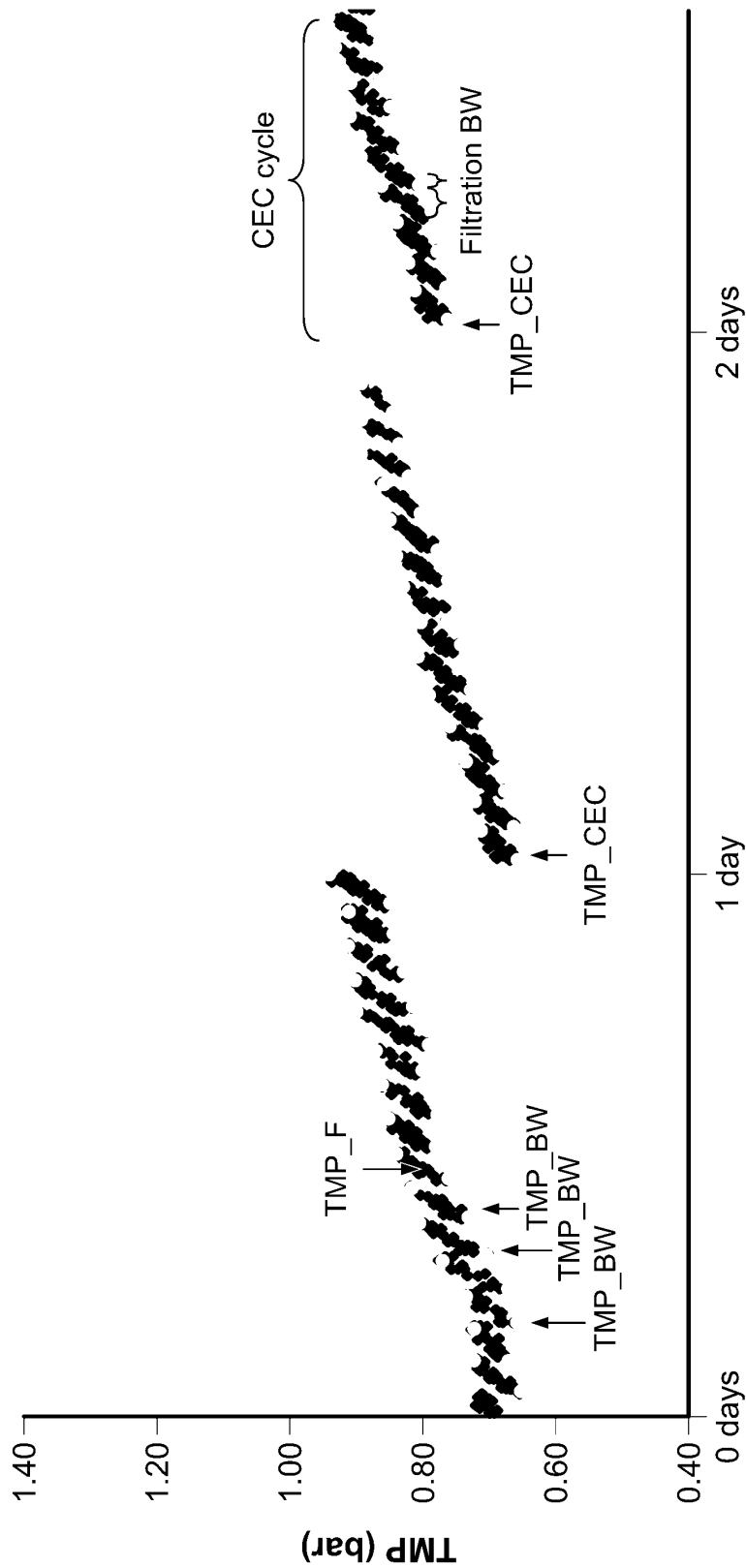
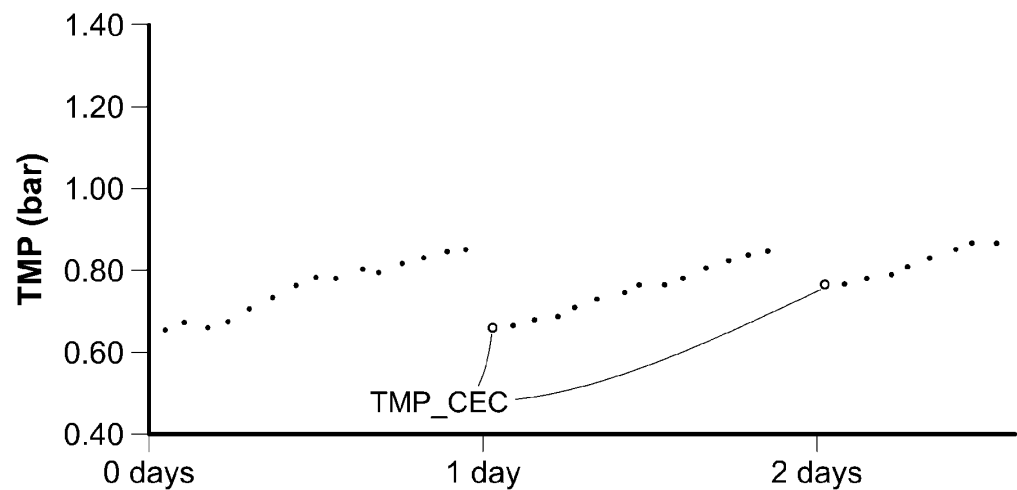
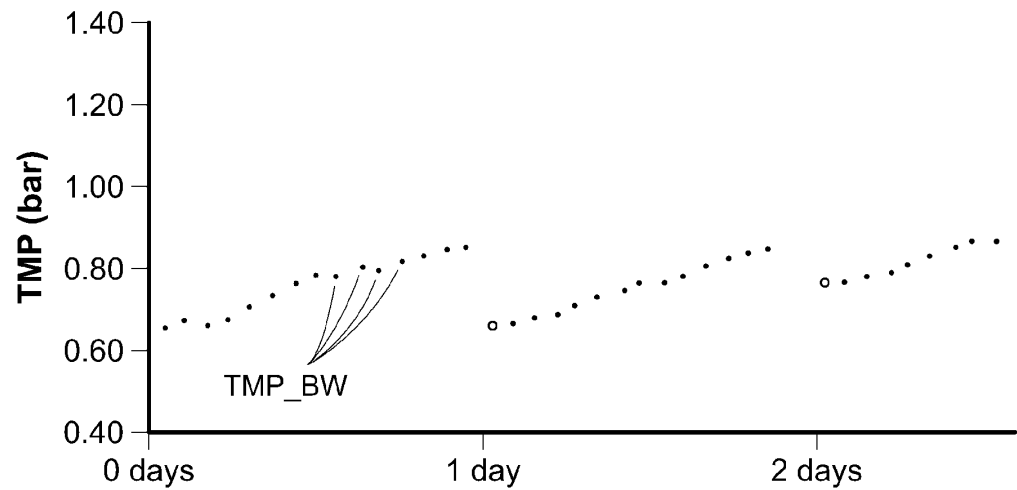
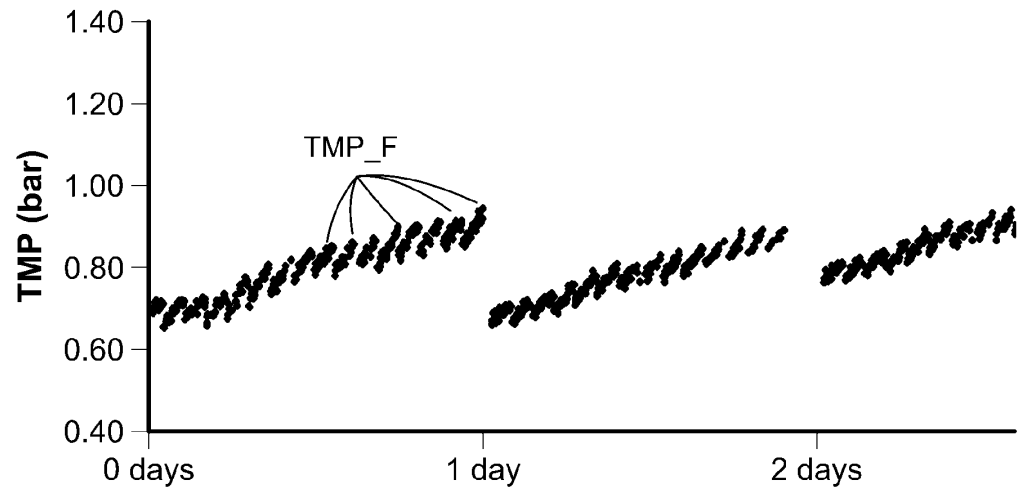


FIG. 20



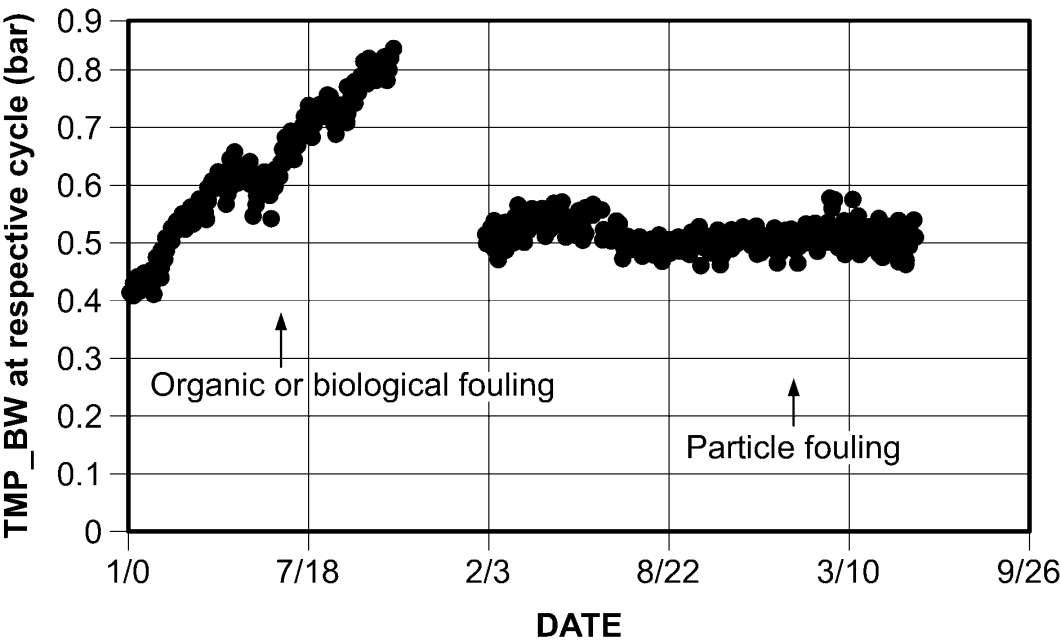


FIG. 21A

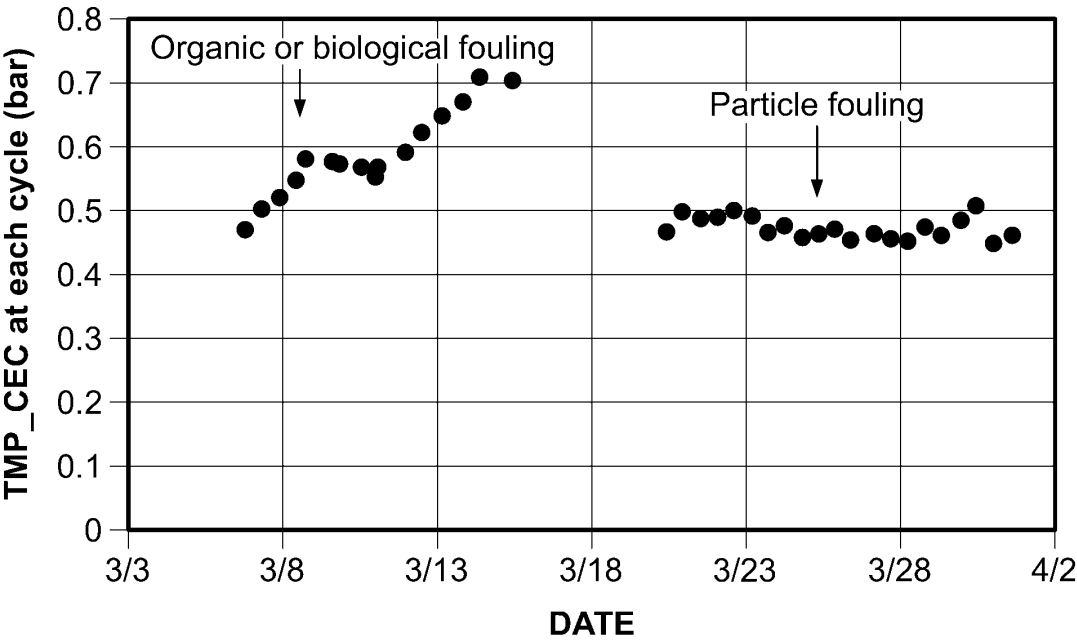


FIG. 21B

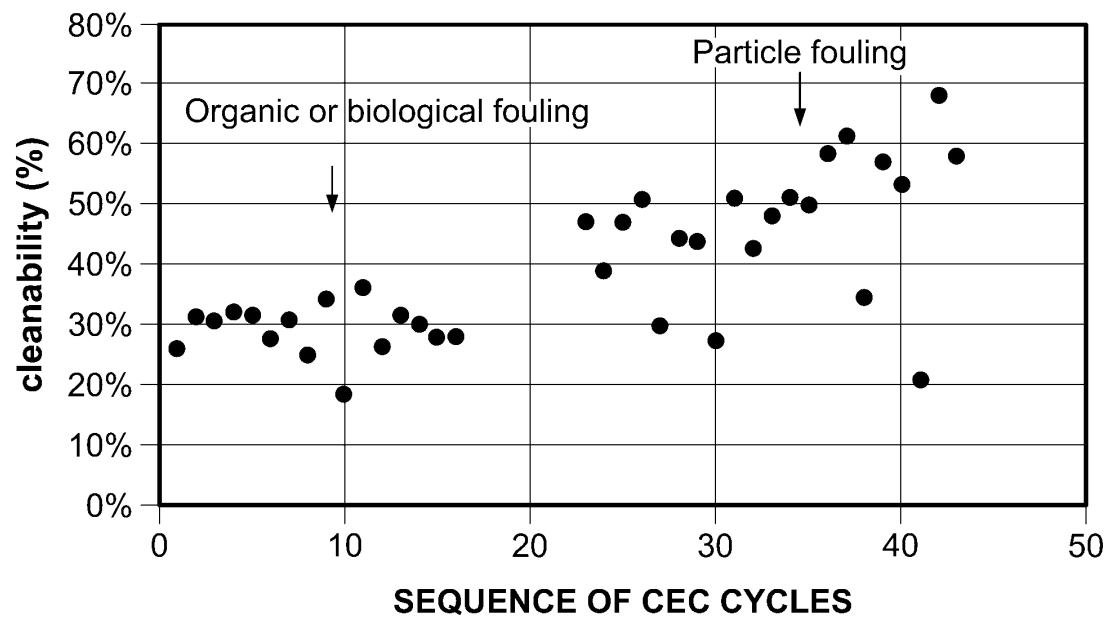


FIG. 21C