



Environmental Sciences Research Institute

Treatment of Wastewater from Steel Industry Using Various Type of Natural and Chemical Coagulants

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NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

NEWEA

WORKING FOR WATER QUALITY





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Steel industries are major contributors to the world economy, especially in developing nations

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Steel industries are one of the main contributors to industrial pollution worldwide

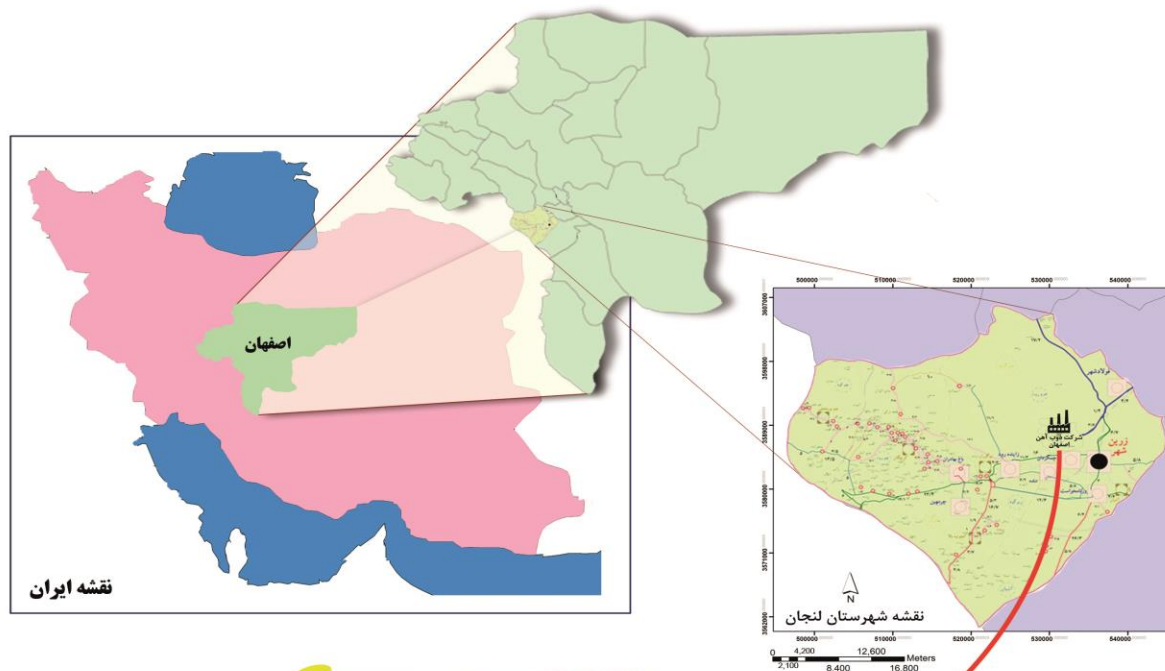


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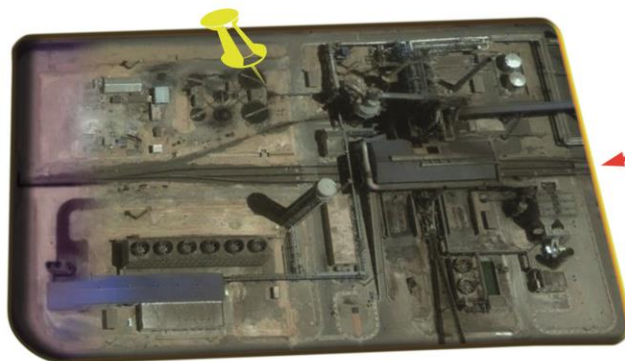
Discussion



نقشه ایران

نقشه شهرستان لنجان
0 4,200 8,400 12,600 16,800 Meters

ذوب آهن اصفهان
X: 531708 E
Y: 3586926 N



Natural and Chemical Coagulants



Ferric Chloride
($\text{FeCl}_3 - 6\text{H}_2\text{O}$)

Alum [Al_2
(SO_4) $3 \cdot 16\text{H}_2\text{O}$]

**Poly Aluminum
Chloride (PAC)**
[$\text{Al}_2(\text{OH})_n\text{Cl}_{6-n} \cdot$
 $n \cdot x\text{H}_2\text{O}$] $_m$

**Dolomite
Powder**

Wheat Starch

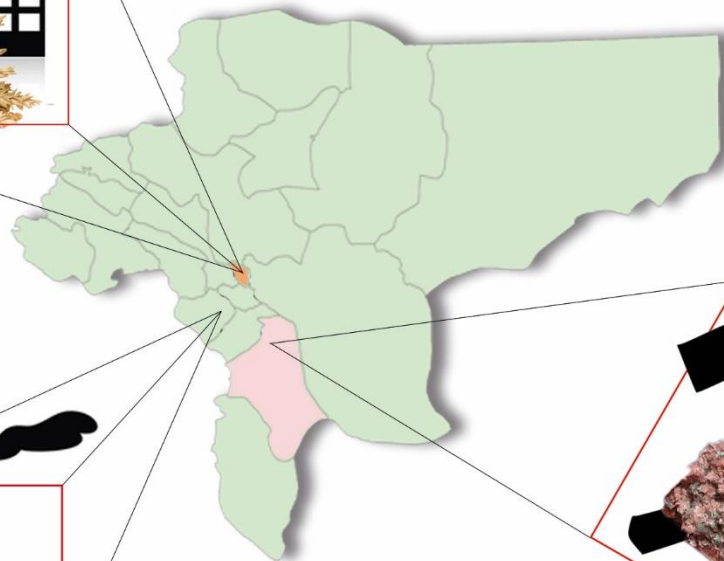
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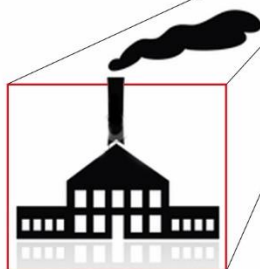
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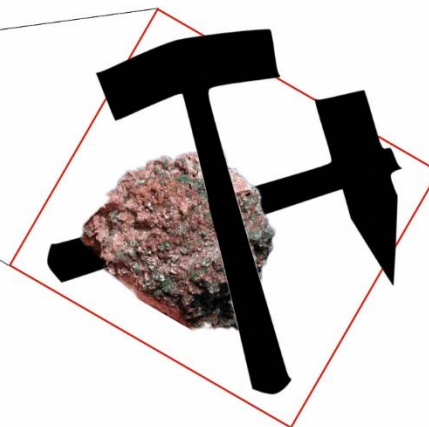
Amin Starch Manufacturer



Esfahan Steel Company



Shahreza Dolomite Mine



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Physico-chemical characteristics of starch coagulant

Description of test	Standard
Appearance	White
Smell and taste	Free of undesirable odors and flavors
pH	4.5-7
Humidity	Max 12 %
Purity	80-85 %
Total ash	Max 0.25 %
Proteins NX : 6/25	Max 0.4 %
Fat	Max 0.3 %
Physical Review	No foreign objects
Impurity	Wheat bran, sulfated ash and gluten
Type of abuse	Food Industry

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Chemical analysis of dolomite

Compound Name	(%)Amount	Compound Name	(%)Amount
SO ₃	0.01 ≤ 0	CaO	31.69
P ₂ O ₅	0.01 ≤ 0	MgO	20.6
K ₂ O	0.01 ≤ 0	SiO ₂	0.4
Na ₂ O	0.01 ≤ 0	Fe ₂ O ₃	0.26
L.O.I	46.87	Al ₂ O ₃	0.11

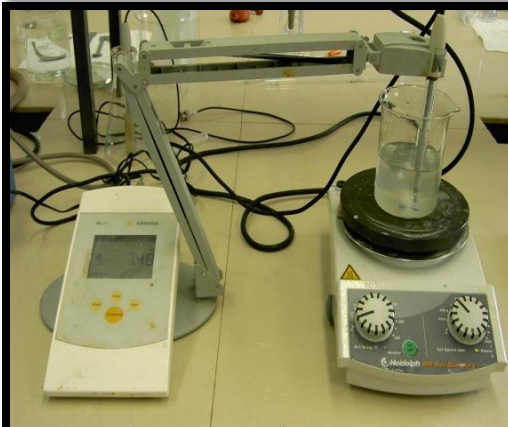


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Physico-chemical characteristics of raw wastewater of blast furnace no.3

Parameters	Magnitude
pH	8.95
Temperature (C°)	50-55
Color	pitch-black
Odor	Coke
Chemical oxygen demand (mg l ⁻¹)	3750
Total dissolved solids (mg l ⁻¹)	17800
Total suspended solids (mg l ⁻¹)	9650
Total solids (mg l ⁻¹)	27450
EC (mhos/cm)	37.7
Turbidity (NTU)	1942
NH ₃ (mg l ⁻¹)	NH ₃ -N:435, NH ₃ :530, NH ₄ :560

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Description	Factors
Natural pH of wastewater - 7	pH
PAC – Alum- FeCl ₃ -Wheat Starch-Dolomite Powder	Coagulant Type
1 – 3 – 5 – 7 – 10 – 15 (ppm)	Coagulant dosage in Chemical Phase
5 – 10 – 30 – 60 – 100 – 150 (ppm)	Coagulant dosage in Natural Phase
0 – 2 – 5 – 10 – 30 – 60 (ppm) Natural Coagulants	Coagulant dosage in Mix Phase
1 – 1 – 1 – 1 – 1 – 1 (ppm) Chemical Coagulants	
Optimum Dose	

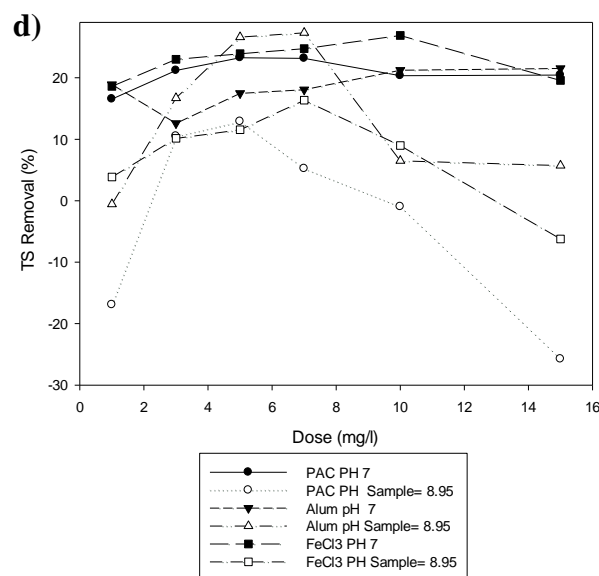
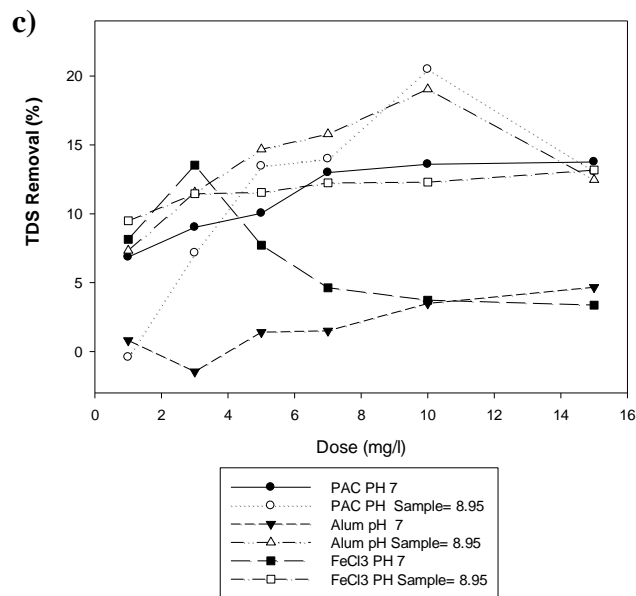
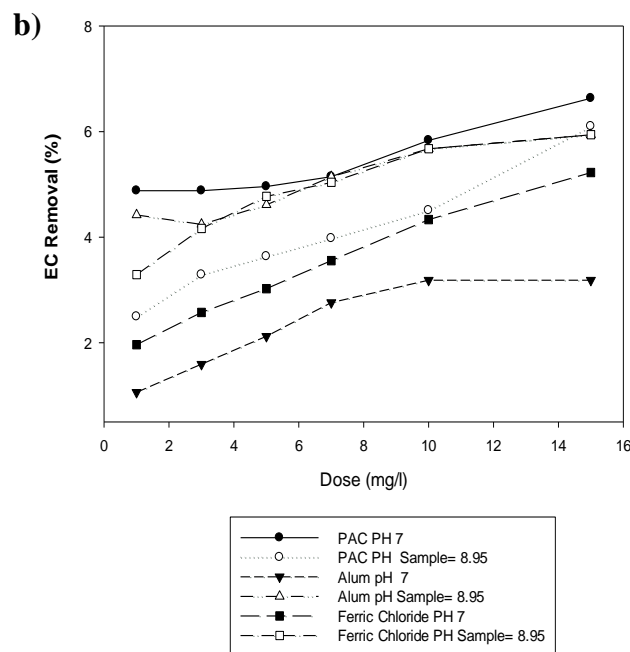
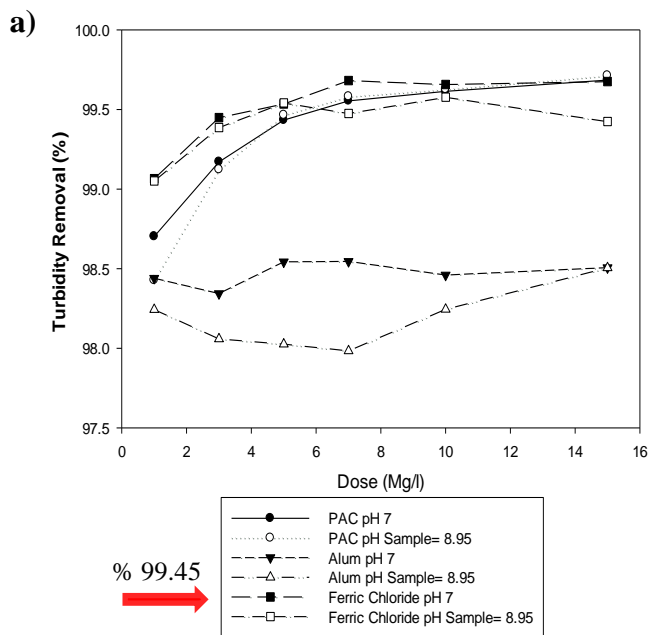


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Effect of various chemical coagulant dosages (PAC, alum, FeCl₃) on a) turbidity removal pH (natural-7) b) EC removal pH (natural-7) c) TDS removal pH (natural-7) d) TS removal pH (natural-7).

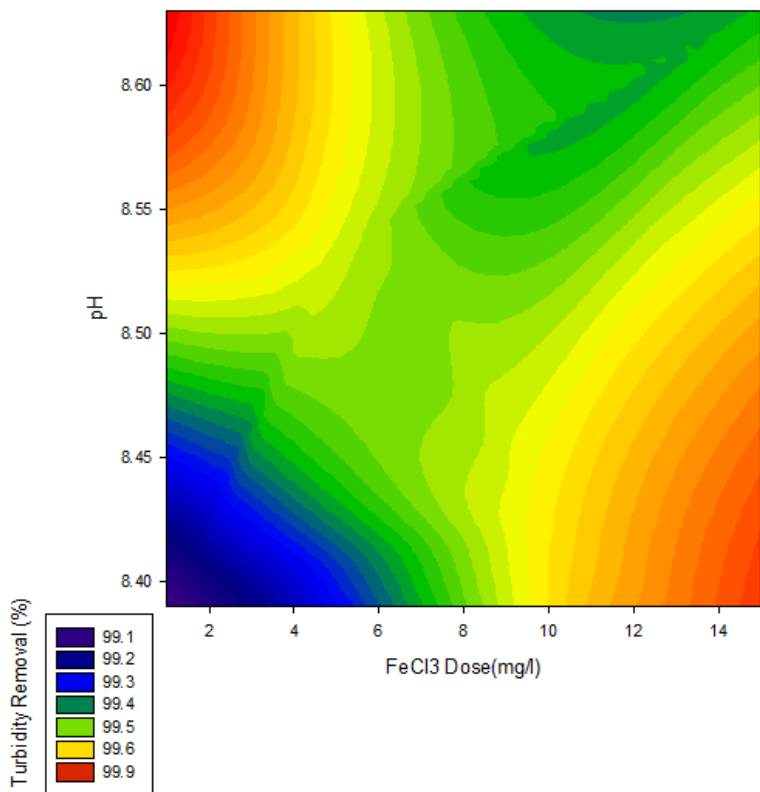
Effect of various factors on turbidity removal

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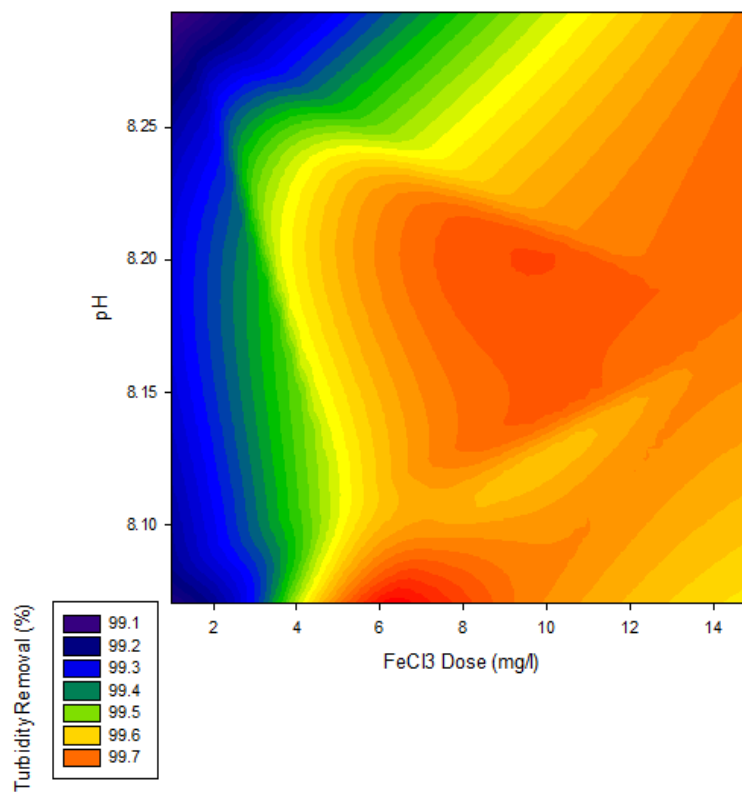
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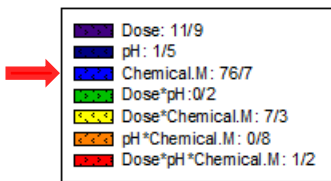
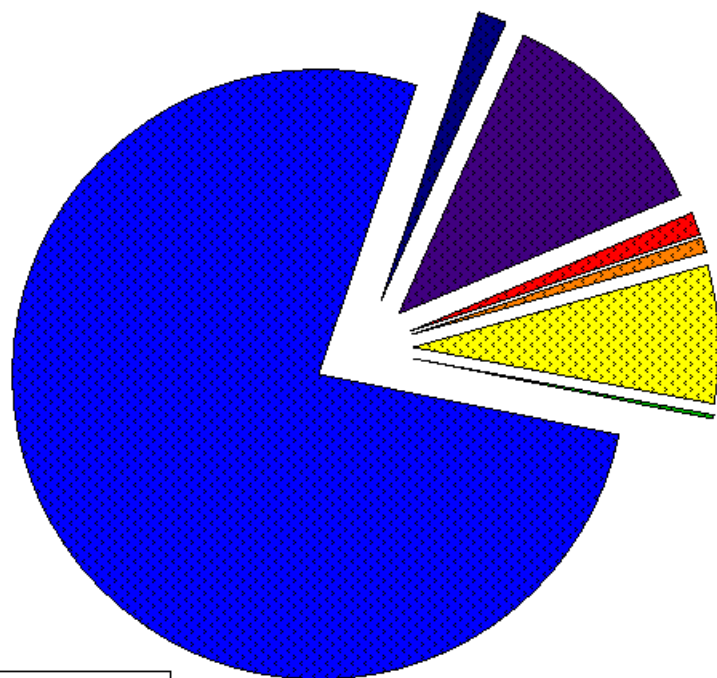
pH Sample



pH7

Effect of various factors on turbidity removal

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Microscope Images of the flocs (mm) produced by 1 mg/l PAC, 1 mg/l alum and 1 mg/l FeCl₃ at 30 min sedimentation time

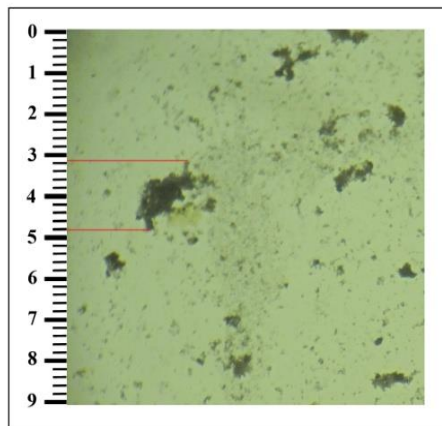
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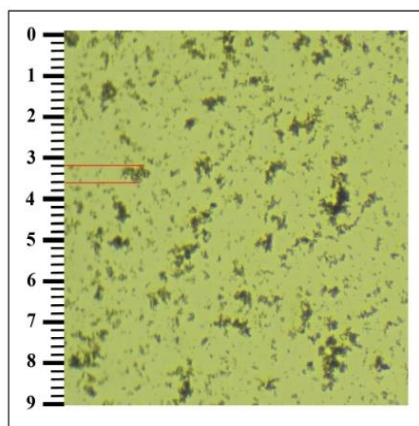
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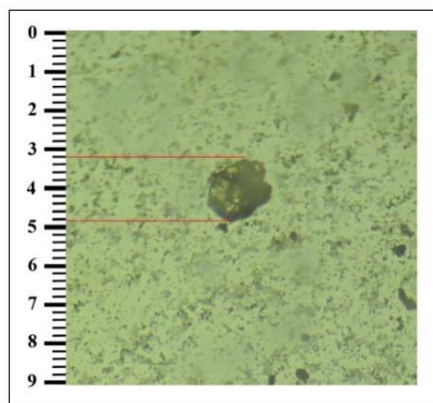
PAC



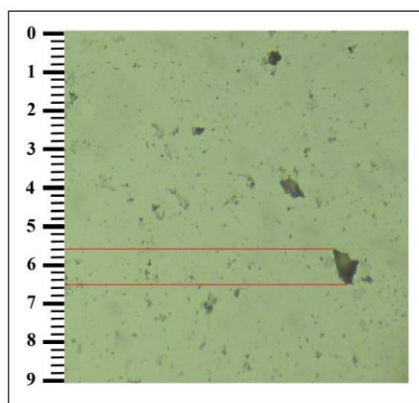
Raw Wastewater



FeCl₃



Alum



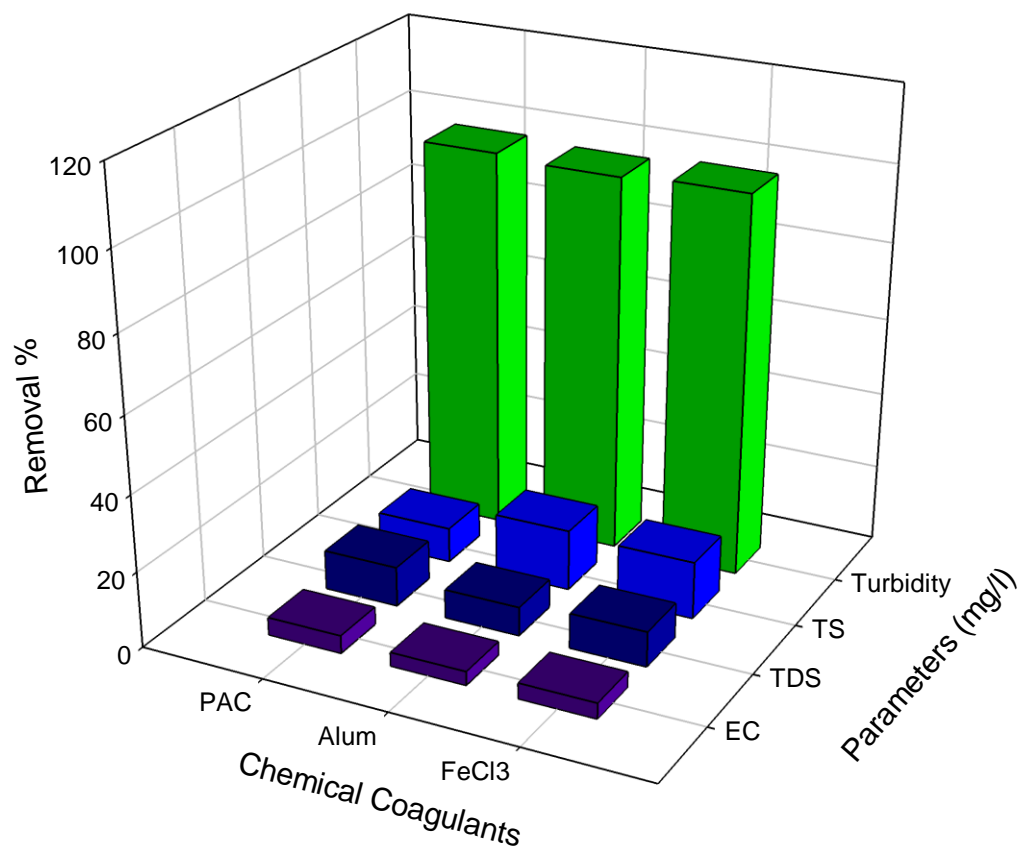


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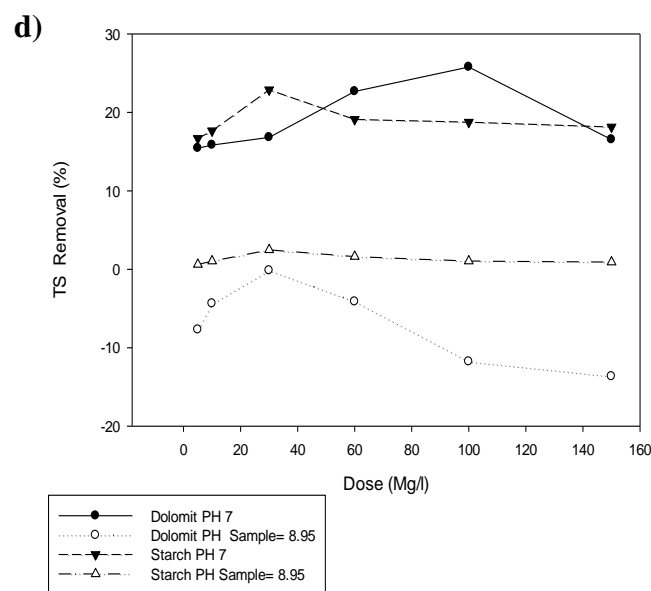
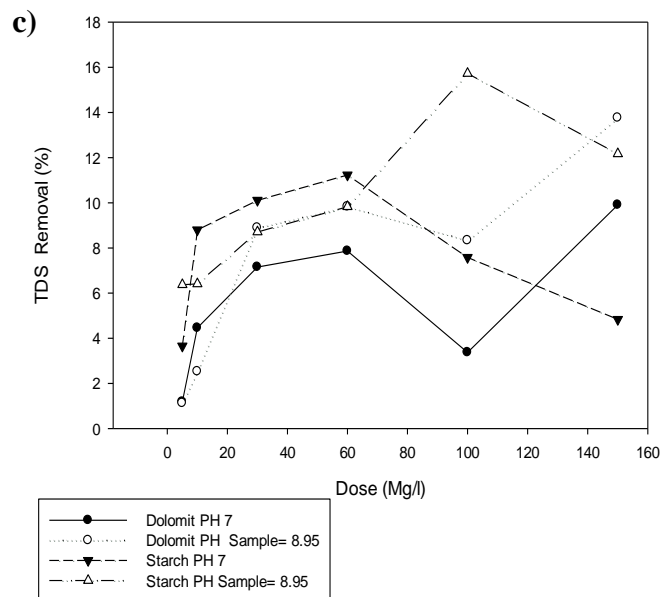
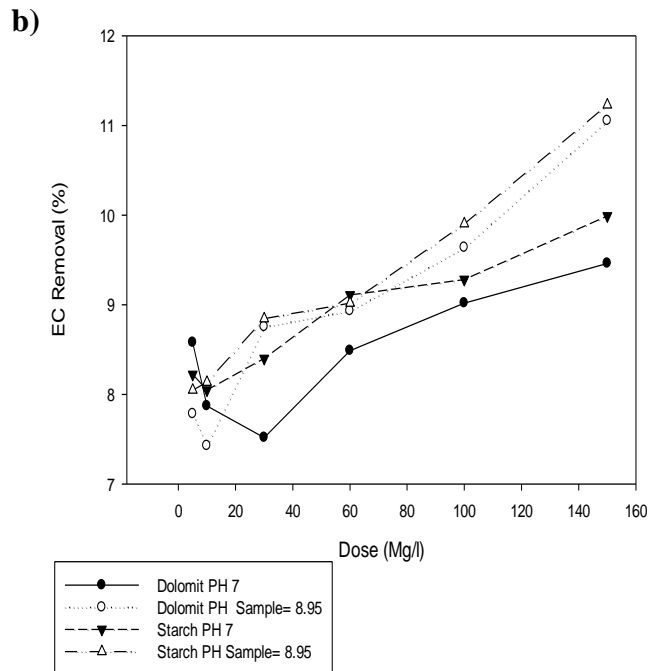
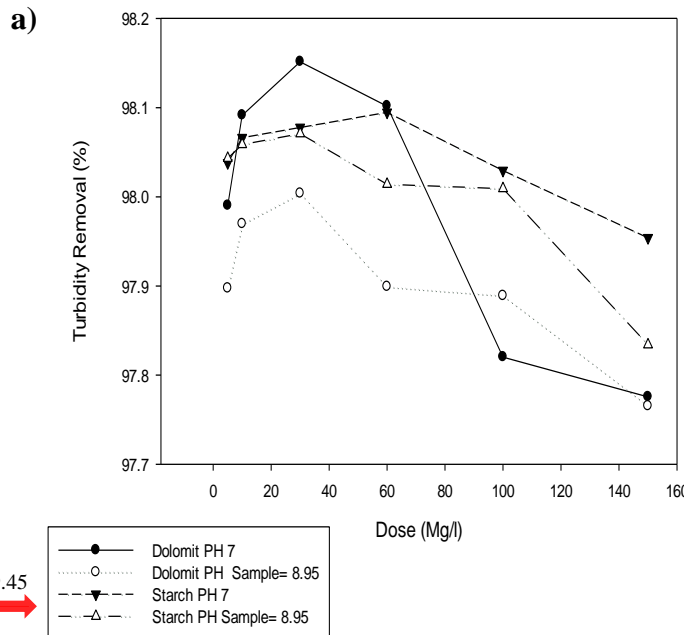


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Effect of various natural coagulant dosages (wheat starch, dolomite) on a) turbidity removal pH (natural-7) b) EC removal pH (natural-7) c) TDS removal pH (natural-7) d) TS removal pH (natural-7).

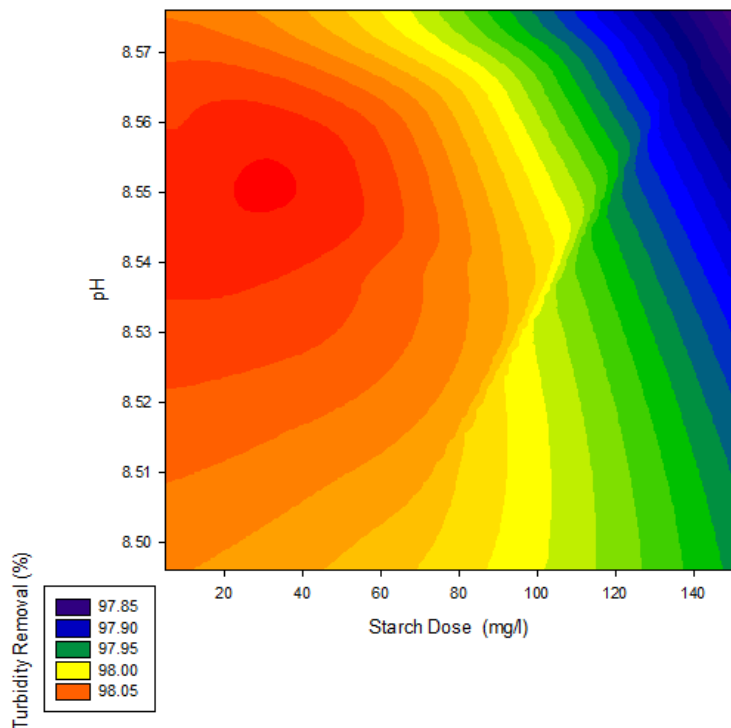
Effect of various factors on turbidity removal

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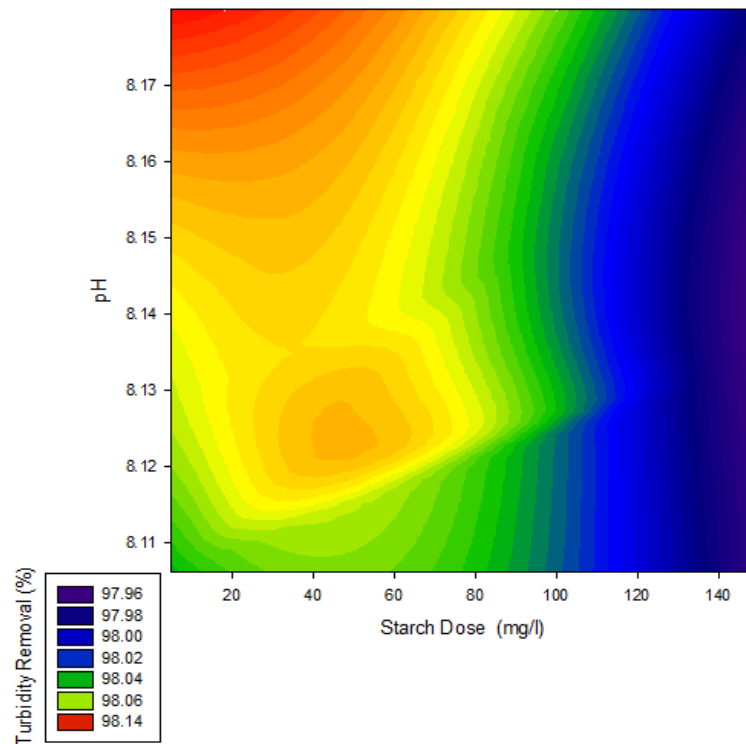
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pH Sample



pH7

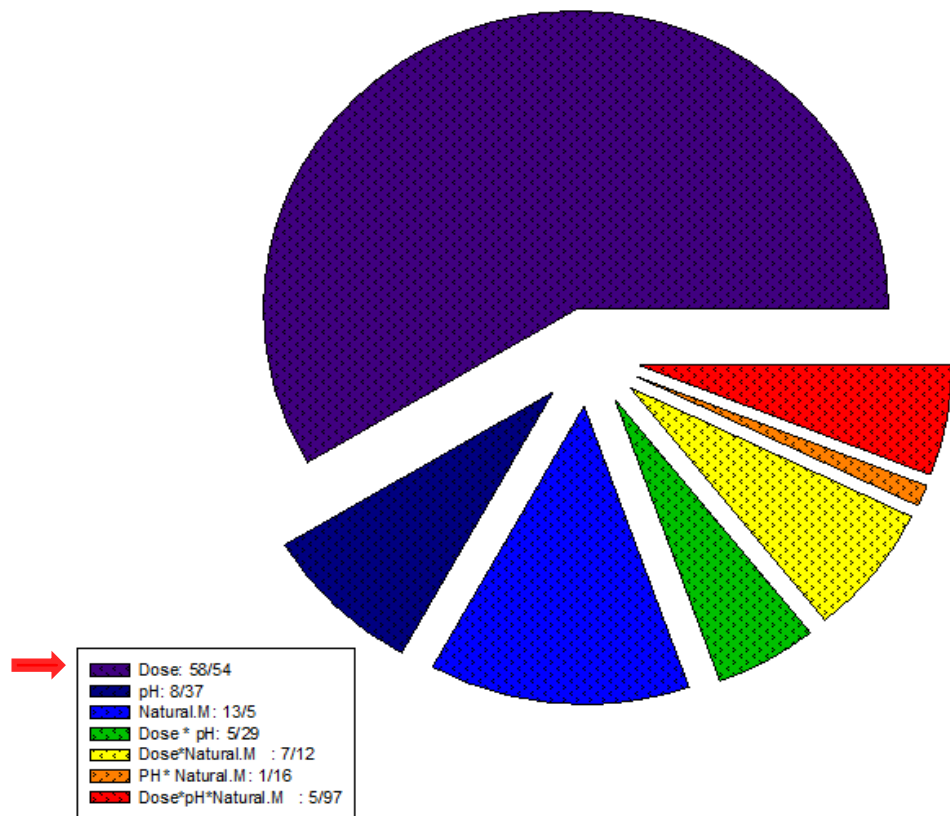
Effect of various factors on turbidity removal

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Microscope Images of the flocs (mm) produced by a) 5 mg/l dolomite and b) 5 mg/l wheat starch at 30 min sedimentation time

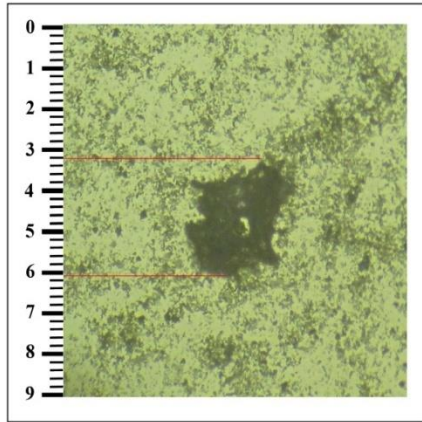
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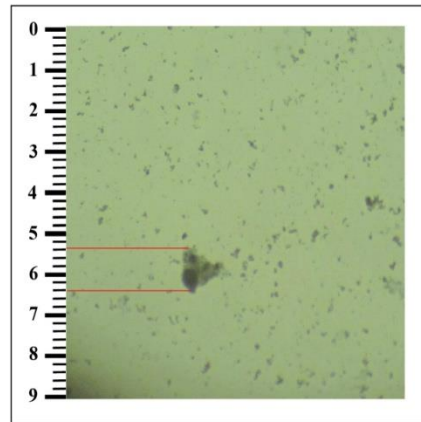
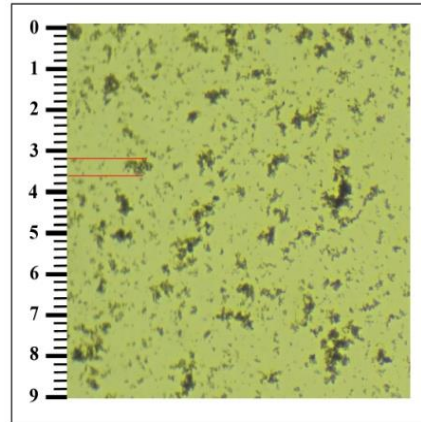
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Dolomit



Raw Wastewater



Starch

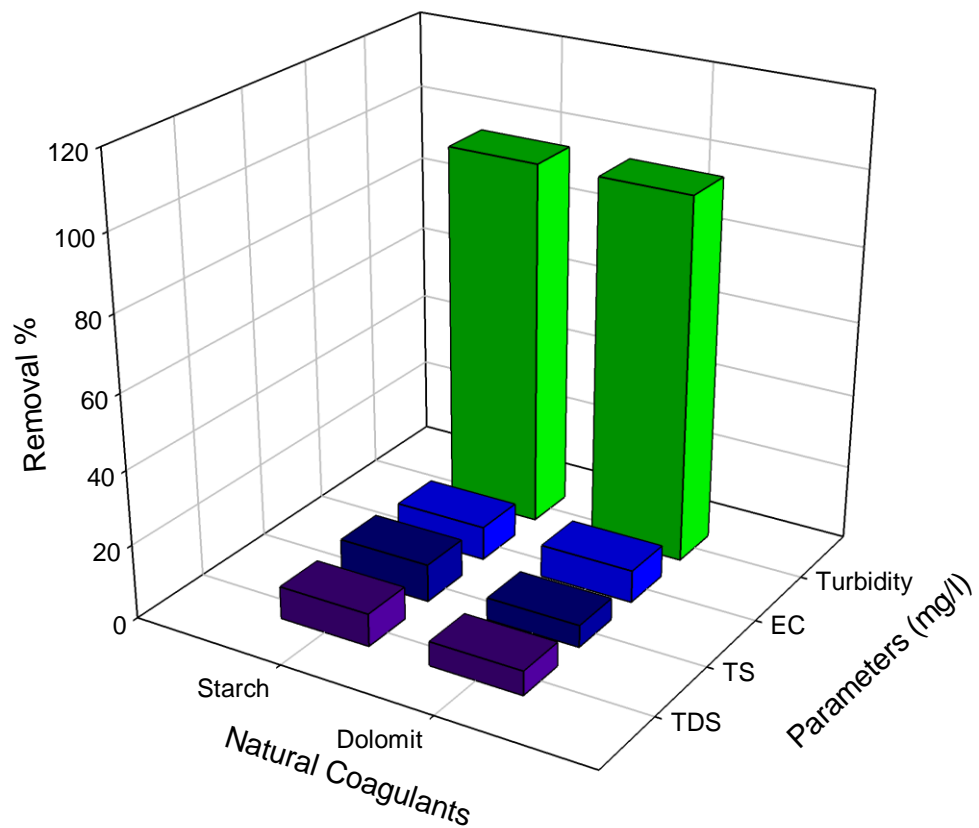


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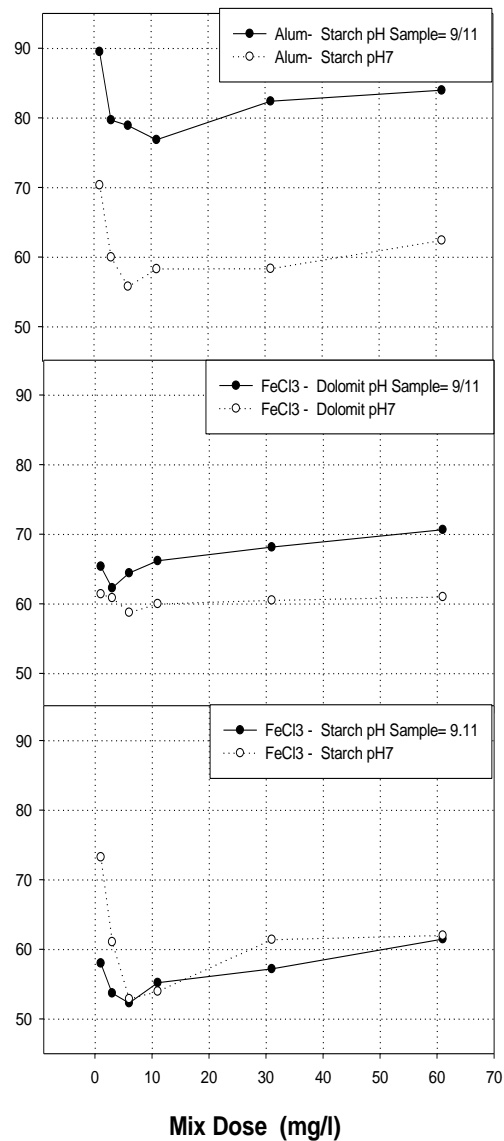
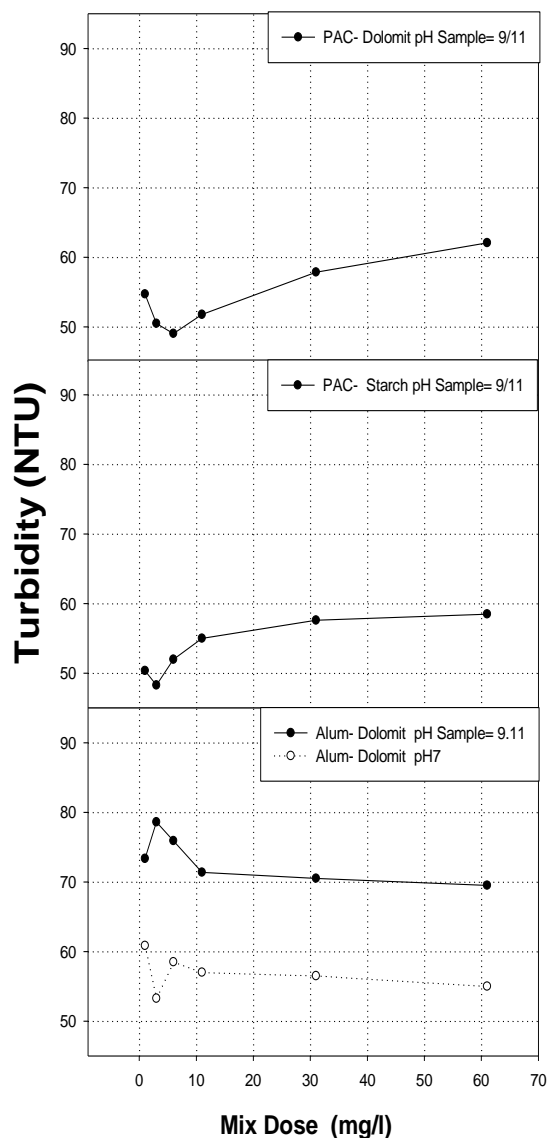
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%97



Effect of chemical/natural coagulants combinations dosages on turbidity removal pH (natural-7)



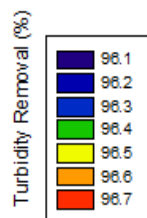
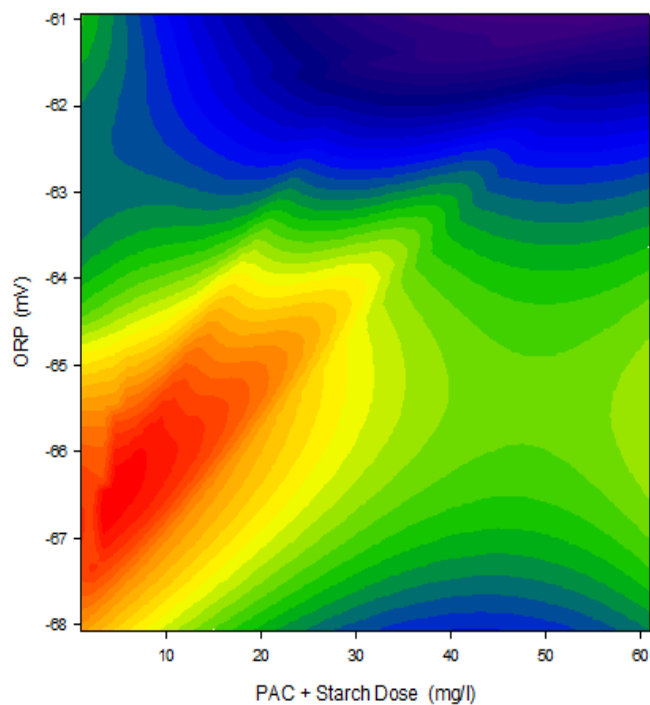
Effect of various factors on turbidity removal

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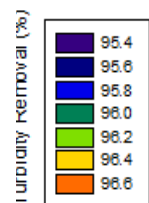
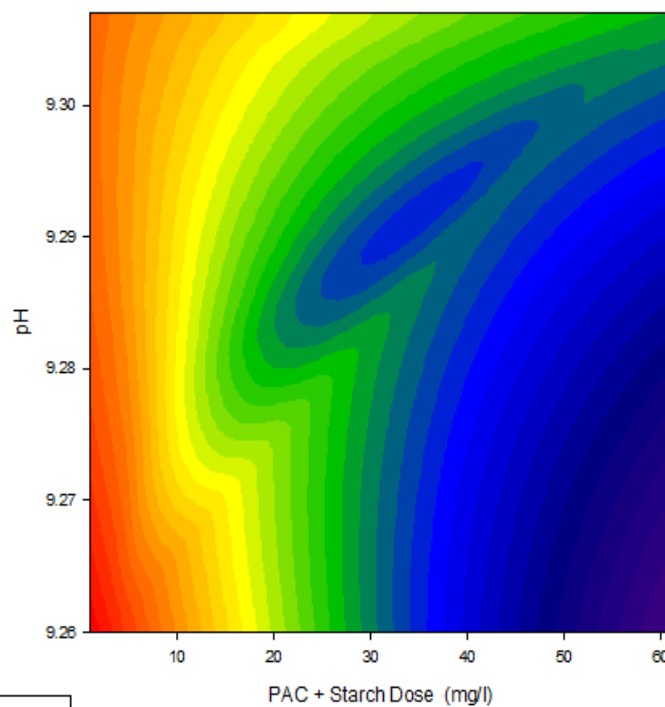
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pH Sample



pH Sample



Effect of various factors on turbidity and EC removal

Turbidity removal							EC removal						
Source	df	Sum of square	Mean square	F value	p value	Impact percent (p%)	Source	df	Sum of square	Mean square	F value	p value	Impact percent (p%)
X ₁	5	866.46	173.29	0.85	0.51	5.46	X ₁	5	47.81	9.56	3.54	0.0051	13.6
X ₂	1	884.36	884.36	4.33	0.03	5.58	X ₂	1	214.57	214.57	79.49	< 0.0001	61.05
X ₃	1	10.8	10.8	0.05	0.81	0.06	X ₃	1	0.16	0.16	0.06	0.80	0.04
X ₄	2	7623.96	3811.98	18.68	<0.0001	48.11	X ₄	2	46.80	23.40	8.67	0.0003	13.31
X ₁ X ₂	5	356	71.2	0.35	0.88	2	X ₁ X ₂	5	3.91	0.78	0.29	0.91	1.11
X ₁ X ₃	5	304.58	60.91	0.3	0.91	1.92	X ₁ X ₃	5	4.61	0.92	0.34	0.88	1.31
X ₁ X ₄	10	429.88	42.98	0.21	0.99	2.71	X ₁ X ₄	10	3.03	0.3	0.11	0.99	0.86
X ₂ X ₃	1	85.17	85.17	0.42	0.51	0.53	X ₂ X ₃	1	3.79	3.79	1.40	0.23	1.07
X ₂ X ₄	1	2928.61	2928.61	14.35	0.0002	18.48	X ₂ X ₄	1	1.12	1.12	0.41	0.52	0.31
X ₃ X ₄	2	1107.85	553.92	2.71	0.07	6.99	X ₃ X ₄	2	0.02	0.01	0	0.99	0.005
X ₁ X ₂ X ₃	5	188.14	37.62	0.18	0.96	1.18	X ₁ X ₂ X ₃	5	4.23	0.84	0.31	0.90	1.2
X ₁ X ₂ X ₄	5	174.56	34.91	0.17	0.97	1.10	X ₁ X ₂ X ₄	5	3.98	0.79	0.3	0.91	1.13
X ₂ X ₃ X ₄	1	497.29	497.29	2.44	0.12	3.13	X ₂ X ₃ X ₄	1	3.77	3.77	1.4	0.23	1.07
X ₁ X ₃ X ₄	10	255.3	25.53	0.13	0.99	1.61	X ₁ X ₃ X ₄	10	12.89	1.28	0.48	0.9	3.66
X ₁ X ₂ X ₃ X ₄	5	132.93	26.58	0.13	0.98	0.83	X ₁ X ₂ X ₃ X ₄	5	0.66	0.13	0.05	0.99	0.18
Total	58	15845.9	-	-	-	100	Total	58	351.41	-	-	-	100

Factors: coagulant dosage (mg/l; X₁), initial pH (X₂), type of chemical coagulant (X₃) and type of natural coagulant (X₄)

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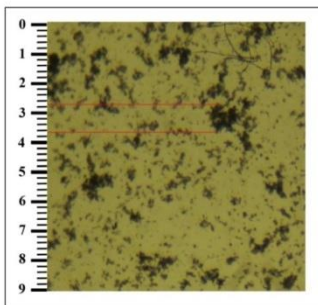
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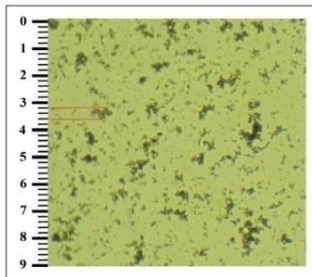
Discussion



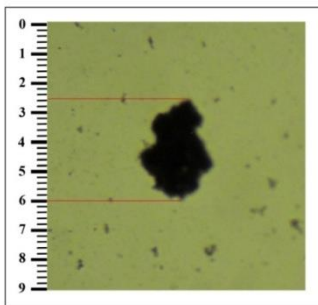
PAC -Dolomit



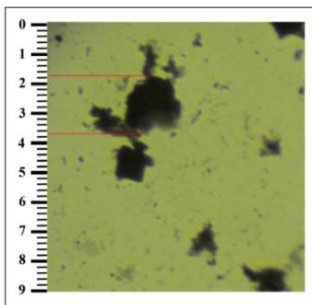
Raw Wastewater



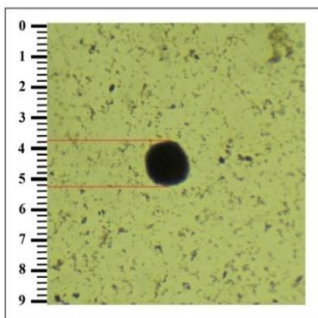
Alum -Dolomit



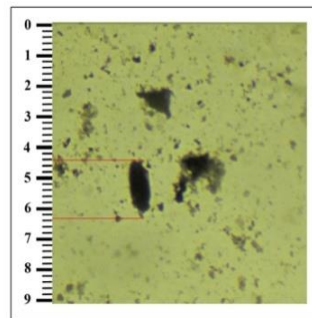
PAC -Starch



FeCl3 -Dolomit

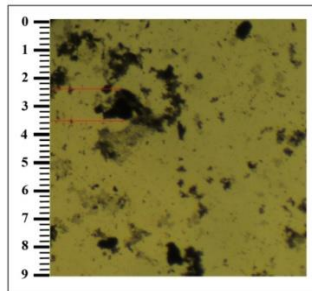


Alum - Starch



Microscope Images of the flocs (mm) produced by 3 mg/l PAC + dolomite, 3 mg/l PAC + wheat starch, 3 mg/l alum + dolomite, 3 mg/l alum + wheat starch, 3 mg/l FeCl_3 + dolomite and 3 mg/l FeCl_3 + wheat starch at 30 min sedimentation time

FeCl3 - Starch

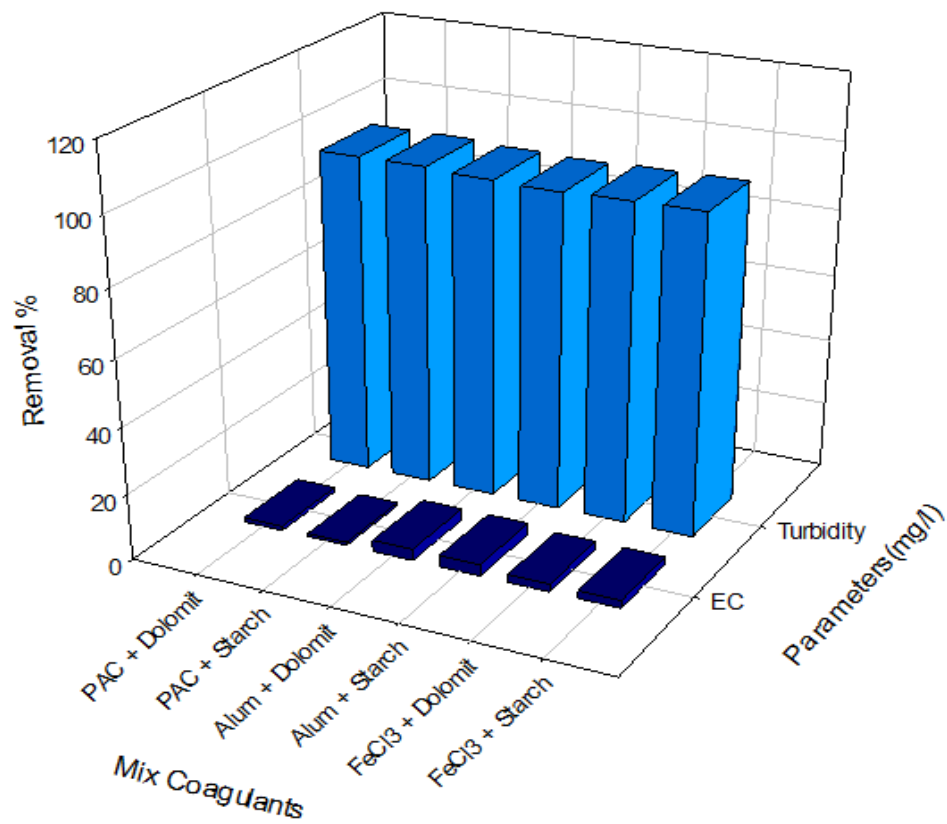


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- The results of this study showed the potential use of dolomite powder and wheat starch as primary or partial natural coagulants to decrease the negative contributions of conventional chemical coagulants.
- This study indicated the potential of using alum and FeCl_3 as a primary chemical coagulant or coagulant aid to reduce the purchase costs of chemical coagulants that should be used in the wastewater treatment process.
- Further study on the cost and benefits and life cycle analysis should be conducted to better utilize wheat starch and dolomite as inexpensive and viable natural sources and to better utilize alum and FeCl_3 as a cheap and efficient chemical coagulant source for wastewater treatment at blast furnace 3 of Isfahan Steel Company.



Thank You!

