

REMOVAL OF ARSENIC AND OTHER INORGANICS FROM WATERS

(**ASTEC** PROCESS)

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ARSENIC TREATMENT METHODS

- Various methods considered to deal with arsenic in hydrometallurgical processes and municipal systems include:
 - oxidation-reduction, precipitation, adsorption, ion exchange, membrane separations, coagulation/filtration, and biological processes
- The **ASTEC** process uses a combination of chemical, modified carbons, and microbes for binding & transformation of arsenic
 - Specific functional groups
 - Removes both Arsenic III and V – no oxidation step required
 - Reactor lifespan of 10 to 15 years expected with <50 ppb arsenic load



STRUCTURE	ACTIVATED CARBON PELLETS IMPREGNATED WITH INORGANIC AND BIOMATERIALS
PARTICLE SIZE	~1/2 x 3/4 INCH PELLETS
SYSTEM RETENTION TIME	2 TO 8 HRS
STATIC As LOADING CAPACITY	450 TO 500 MG/L
OPERATING pH	~4.5 TO 8.5
OPERATING TEMPERATURE	~4° C TO 30° C



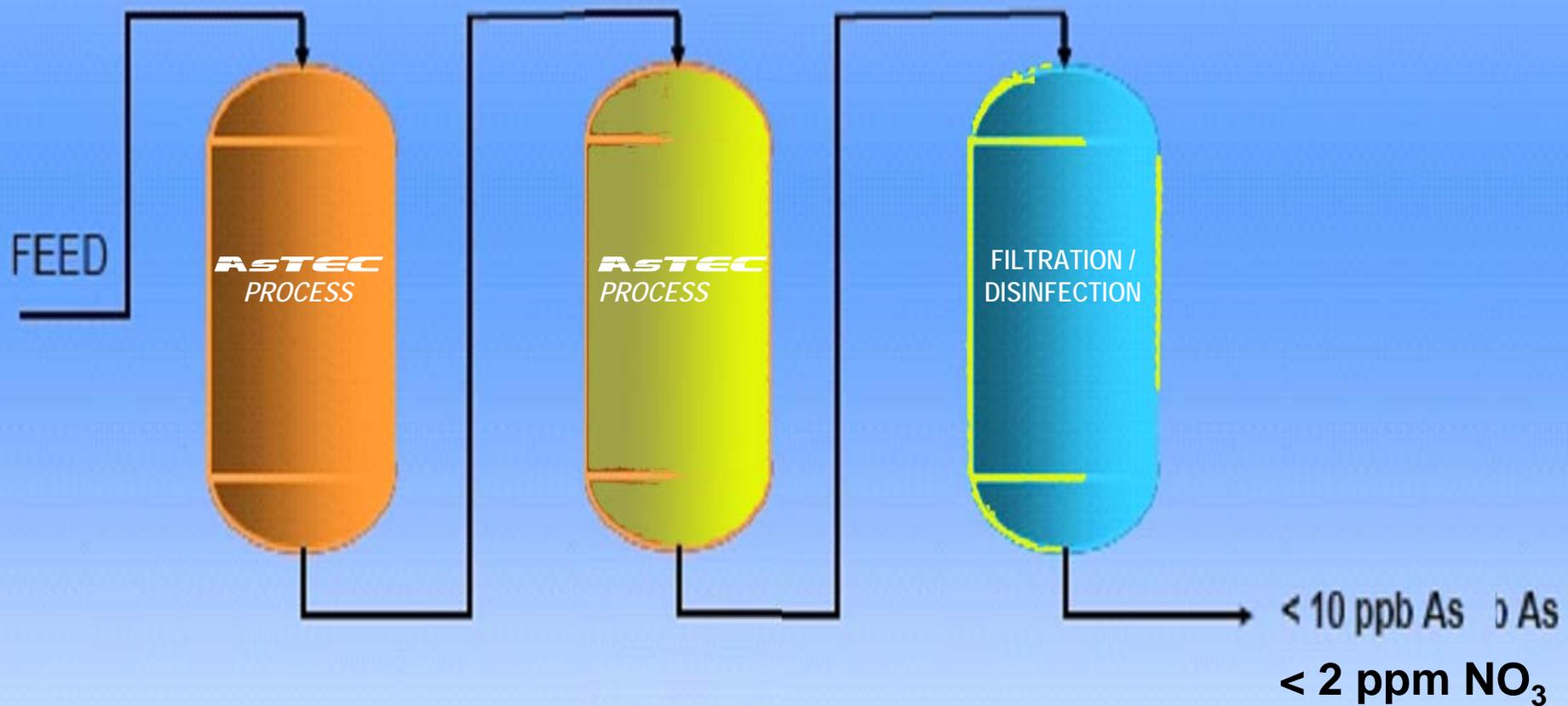


TYPICAL PROPERTIES

HARDNESS	≥ 95	%
PARTICLE DENSITY	~ 0.80	G/CM ³
BULK WEIGHT (APPARENT DENSITY)	~ 480	G/L
TOTAL PORE VOLUME	~ 0.08	CM ³ /G
TOTAL SURFACE AREA	~ 1100	M ² /G
PH VALUE	~ 7	



ASTEC PROCESS



WATER TREATMENT

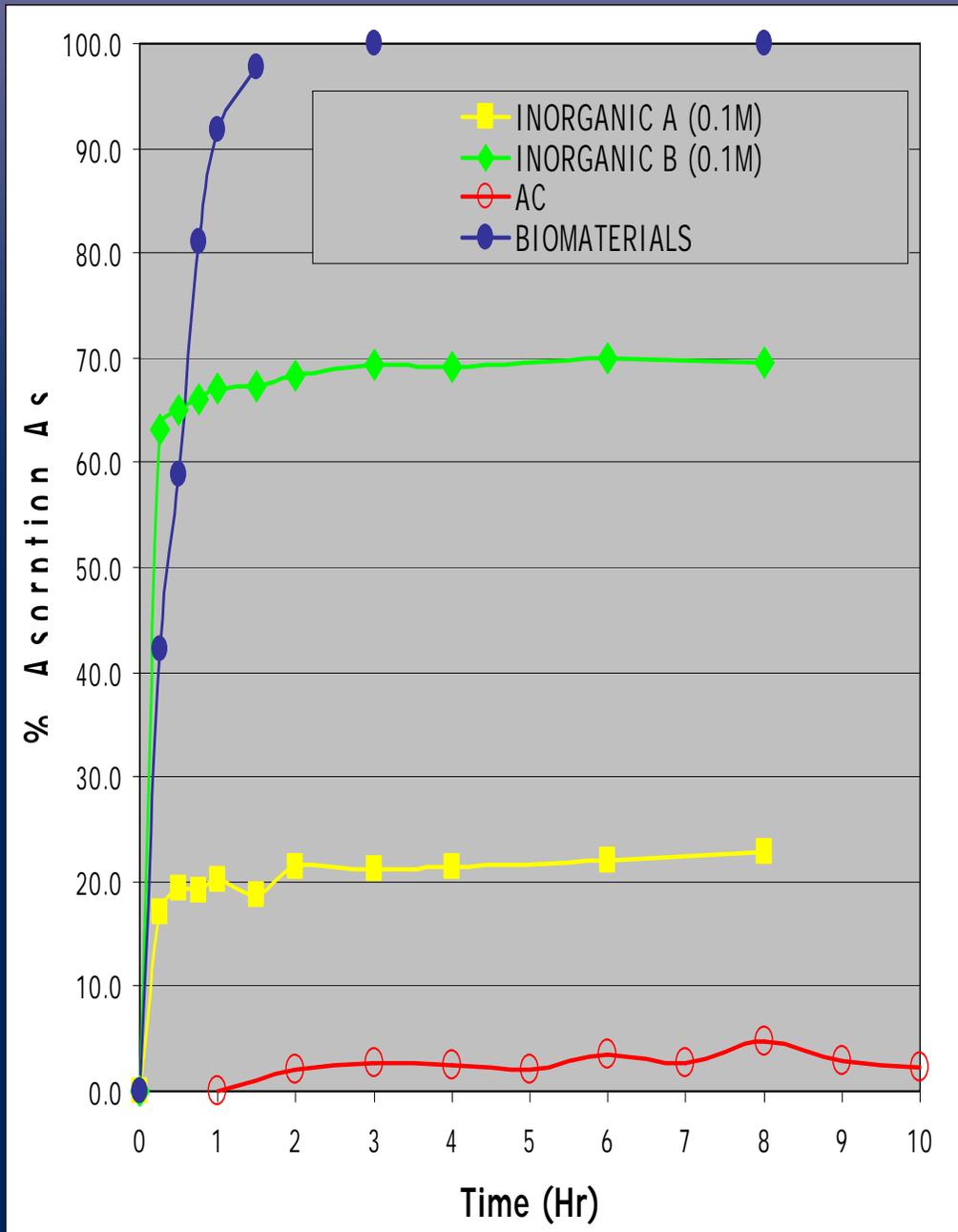
- The **AsTEC** process provides rapid arsenic adsorption kinetics and rapid microbial transformation and removal of arsenate and arsenite along with nitrates and other inorganics
 - Cd, Cr, Hg, NO₃, etc.
- Sorbs cationic metal species in solution and removes them through combined chemical and microbial action
 - Effective for improving taste and odor
 - Minimal bed compaction
 - No release of air-borne arsenic
 - Long reactor lifespan – 10 to 15 yrs



ASTEC

PROCESS

(LABORATORY TESTS)

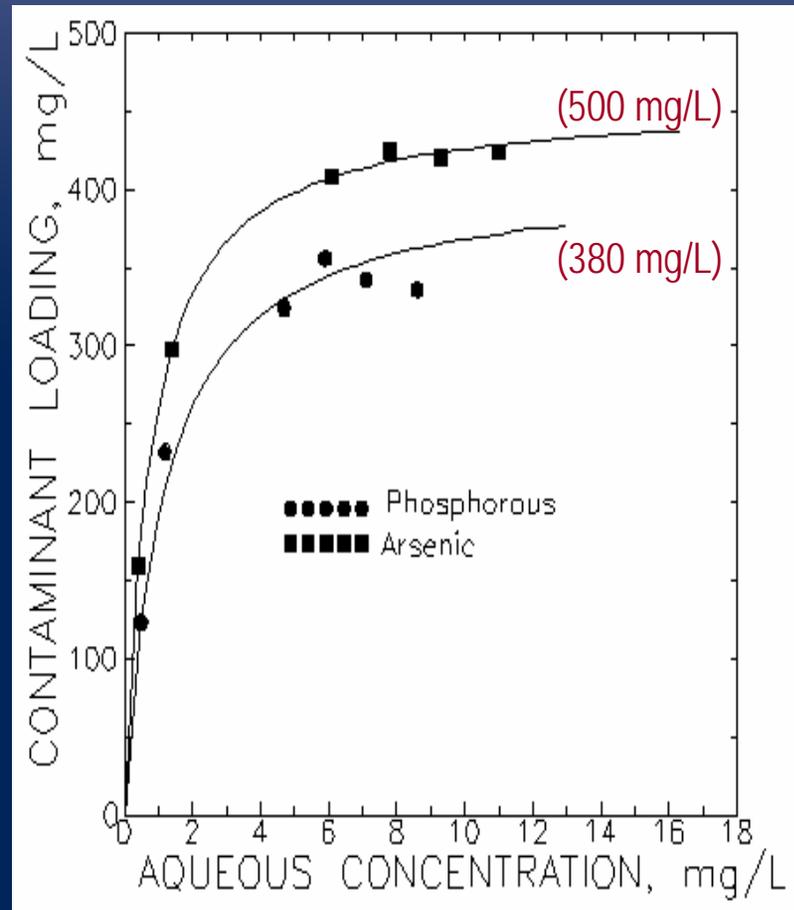
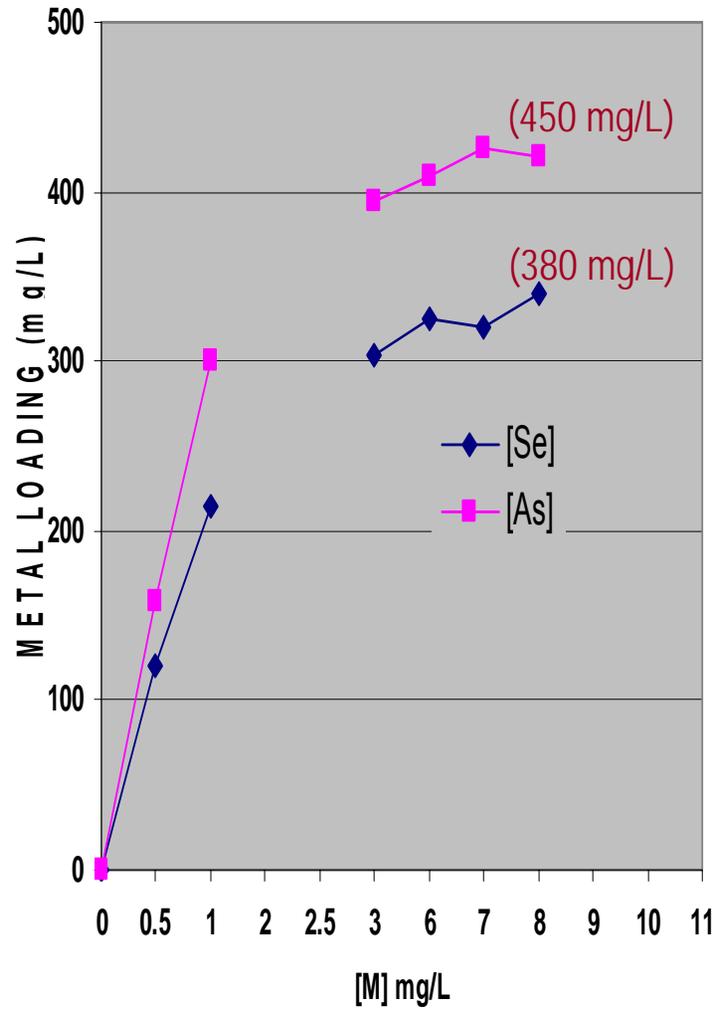


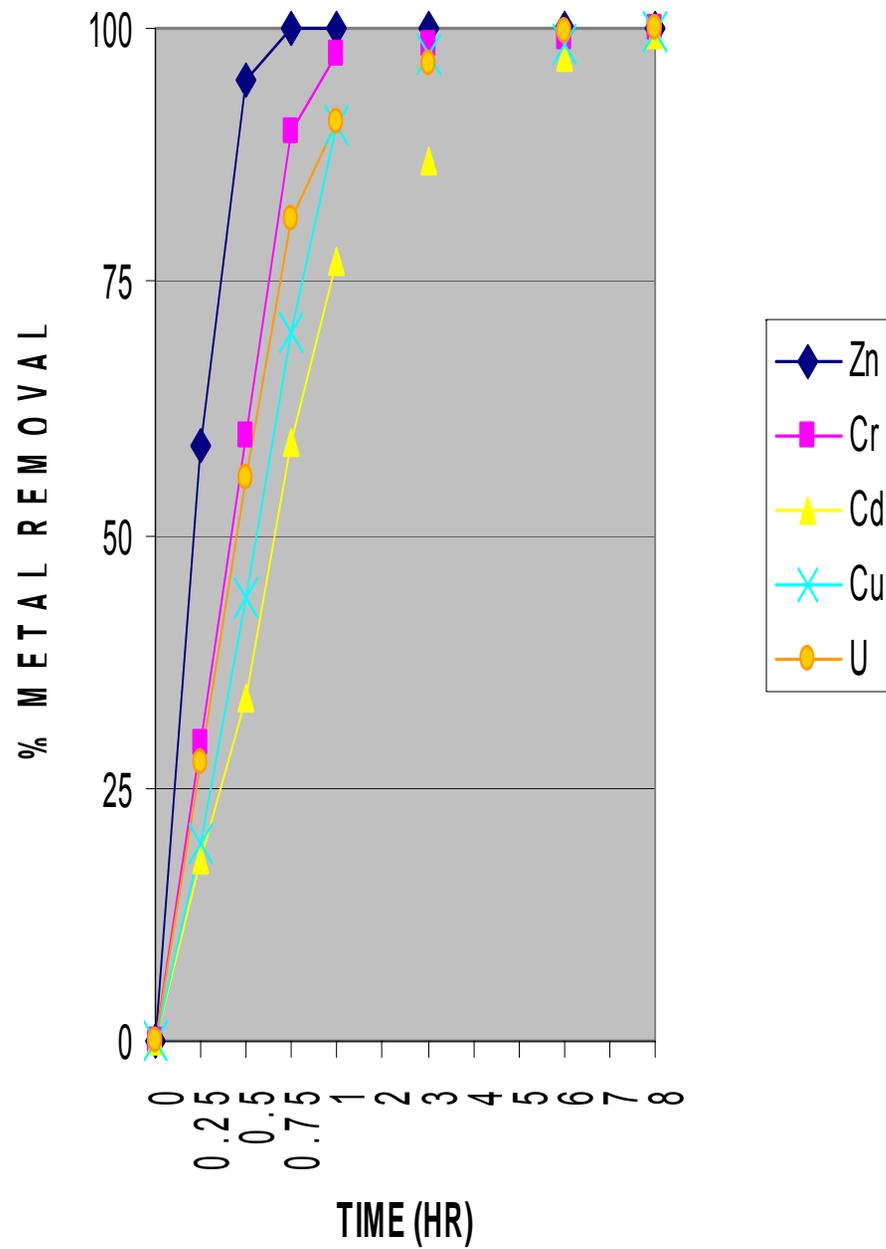
Adams, Diaz, Mankhand, Miller, Pennington, & Chatwin – 2005



AsTEC PROCESS

LOADING CURVES





INOTEC

PROCESSES
(OTHER METALS)



ASTEC PROCESS

PILOT & FULL-SCALE

Arsenic – 0.15 to .024 mg/L

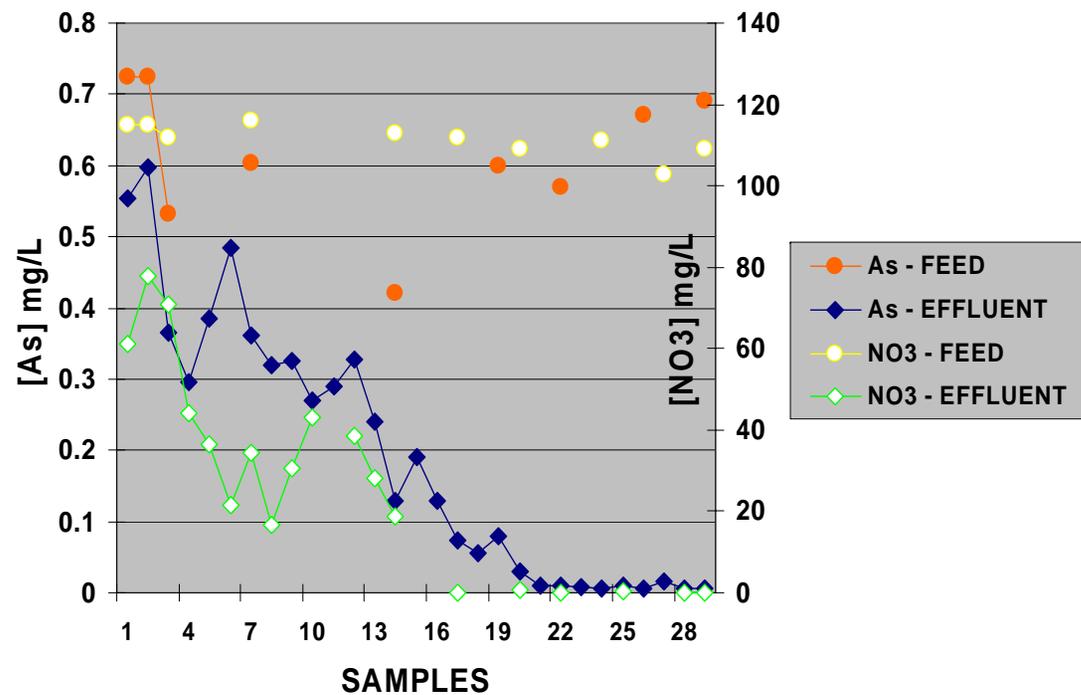
Nitrate – 30 to 35 mg/L

pH ~7.0

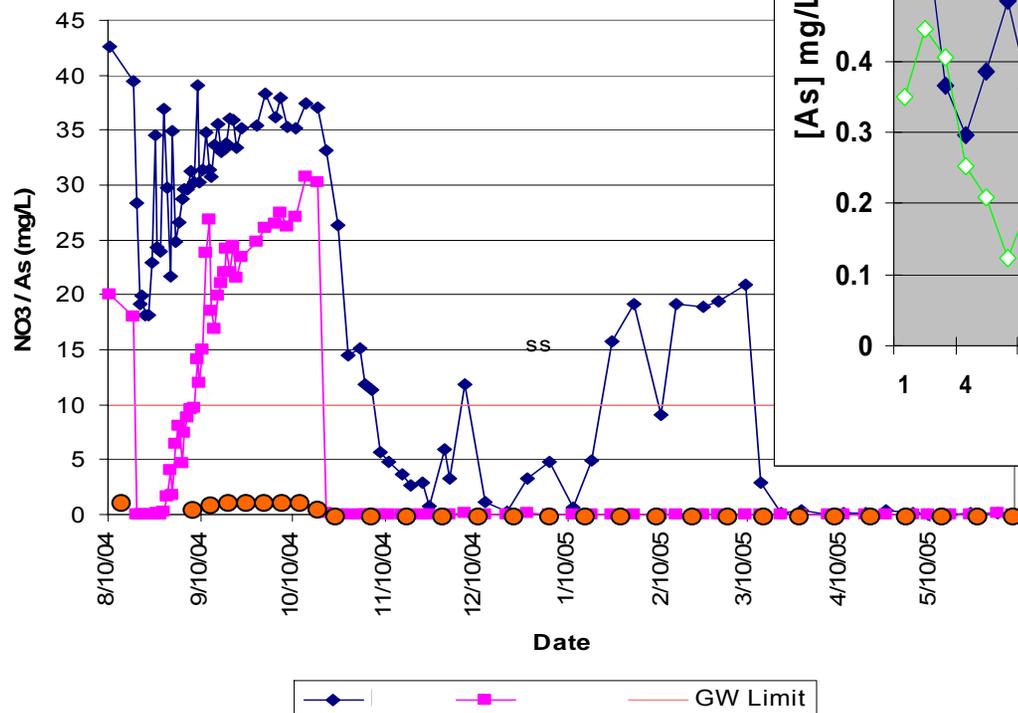
Flow Rate - 20 to 150 gpm

Water Temp. 6° C to 12° C

ARSENIC / NITRATE REMOVAL



Nitrate / Arsenic Levels



ASTEC PROCESS

(A COMBINED CHEMICAL AND MICROBIAL PROCESS)

Technology Advantages

- Faster sorption/removal kinetics
- Higher loading capacity
- Better contaminant removal

(< 10 ppb to BELOW DETECTION)

Economic Advantages

- Lower capital & operating costs
- Robust process
- Small footprint
- Long reactor lifespan - >10 years

ASTEC PROCESS - \$0.10 - \$0.25 / 1,000 gal
(CAN BE CONFIGURED TO REMOVE NITRATE AND OTHER METALS)



ASTEC PROCESS

ARSENIC TREATMENTS	ASTEC	Anaerobic /H ₂ S ⁵	Lime ^{2,3,4}	Chemical Reduction ^{2,3,4}	Activated Alumina ^{2,3}	Ion Exchange ²	Ferric Precipitation ^{2,3}	Reverse Osmosis
Treatment Time (hr)	Low (1 – 4)	Medium/ Long	Low	Medium	Medium	Low	Medium	Medium
pH Range	Broad (3 to 8.5)	Medium	Narrow	Narrow	Narrow	Narrow	Narrow	Med/ Broad
Arsenic Concentration (mg/L)	Low/Med/ High (<1 to >50)	Low/Med/ High	Med/ High	Med/High	Med/ High	High	High	Med/ High
Treatment Cost*	Low (\$0.10 to \$0.25 / 1,000 gal)	Low	Med/ High	High	High	High	Low	High
Meets Discharge Criteria	Yes	Yes	No	No	No	Not Always	Not Always	Yes



TYPICAL PROPERTIES

- Applicable to numerous applications – municipalities and point of entry
 - \$0.10 - \$0.25 / 1,000 gal - Operating costs
 - ~\$1.50 / 1,000 gal Capital and operating costs – amortized over 10 yrs
- Patent pending process
 - Removes both Arsenic III and V – no oxidation step required
 - Operating pH – 4.5 to 8.5
 - Broad temperature applicability - 4° C to 30° C
 - Can remove nitrates and other inorganics
 - Cd, Cr, U, Hg, etc.
- Long reactor lifespan – 10 to 15 yrs
 - Reactor lifespan of 10 to 15 years expected with <50 ppb arsenic load





INOTEC

ASTEC *PROCESSS*
FOR ARSENIC REMOVAL

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