DIMINISHING MATERIALS USE AND AIR POLLUTANTS IN FOUNDRIES VIA AN INTEGRATED ADVANCED OXIDATION PROCESS

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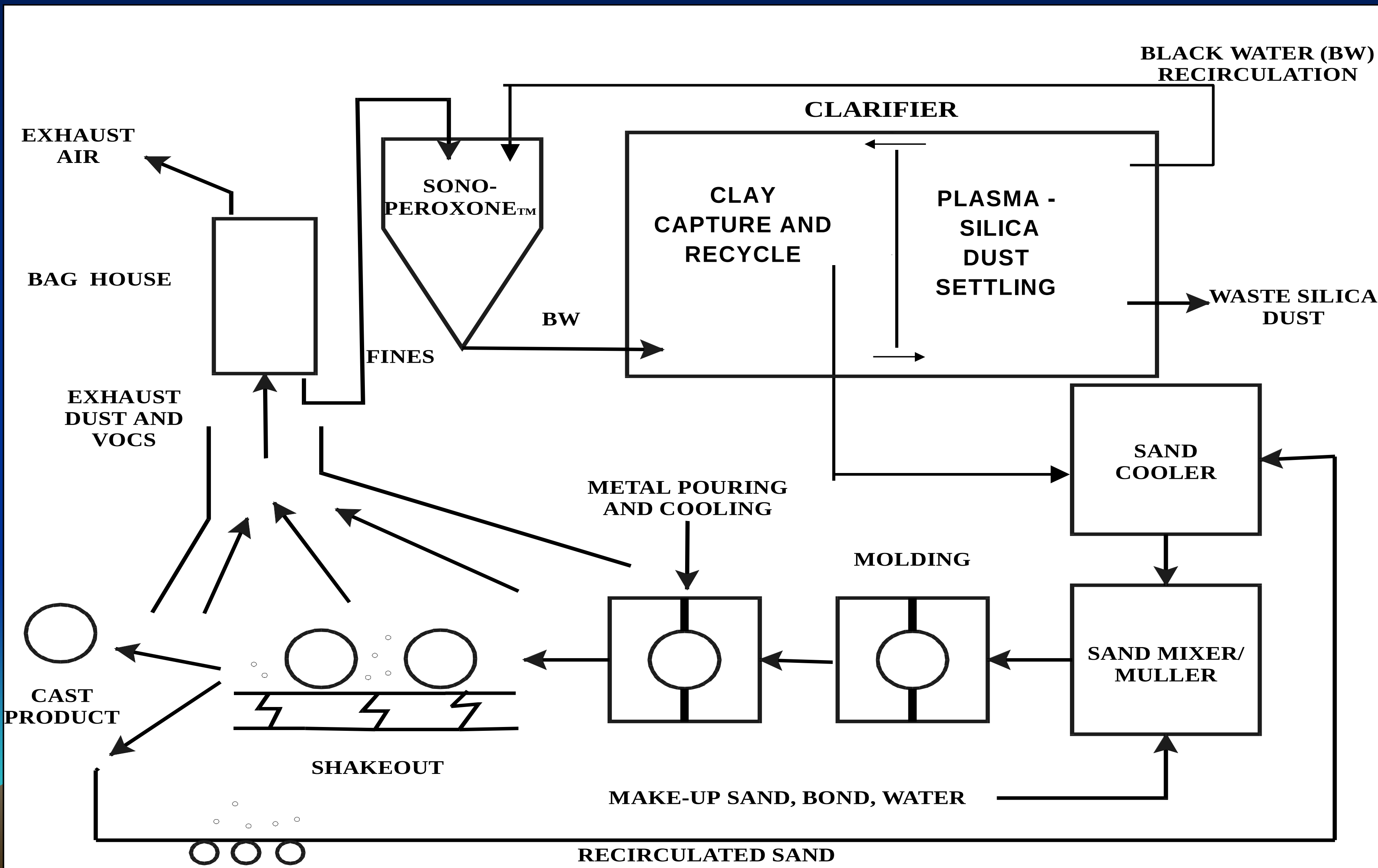
GREENSAND FOUNDRIES FOR CAST IRON AND DUCTILE IRON

- METAL CASTING INDUSTRY EMPLOYS 200,000 PEOPLE IN U.S.
- 3000 FOUNDRIES CAST 10-16 MILLION TONS OF METAL CASTINGS PER YEAR
- 60% OF CASTINGS POURED IN GREEN SAND
- THE FOUNDRY INDUSTRY IS VITAL TO THE STRENGTH OF OUR NATION
- POLLUTION PREVENTION IS KEY

ADVANCED OXIDATION- BLACKWATER CLARIFIER PROCESS FOR POLLUTION PREVENTION IN GREEN SAND FOUNDRY

- HYDROGEN PEROXIDE, OZONE, SONICATION DOSED INTO SLURRY OF BAGHOUSE PARTICULATES
- VIA CLARIFIER, CLAYS RECLAIMED IN BLACKWATER, WHICH IS ROUTED TO SAND COOLER AND GREEN SAND
- THIS ADVANCED OXIDATION PROCESS DIMINISHES EMISSIONS BY 30-70%, AND DIMINISHES CLAY & COAL USE BY 20-35%

ADVANCED OXIDATION IN GREEN SAND FOUNDRY



POLLUTION-PREVENTION; SUSTAINABLE ENVIRONMENT

- AO: SONOPEROXONE™ BACT IN INDIANA & U.S.
- SAVES A FOUNDRY $1-2 MILLION PER YEAR IN LESS WASTE OF COAL, CLAY, AND SAND (PAYS FOR ITSELF IN 3-18 MONTHS)
- TESTS SHOW COMPLIANCE WITH NEW EPA STANDARD OF 20 PPMV VOC'S (VOLATILE ORGANIC COMPOUNDS)
- AO NOW USED ON 15-20 FOUNDRY LINES THAT PRODUCE 5-10% OF U.S. CASTINGS
- (WAS USED ON 4-5 LINES WHEN THIS RESEARCH STARTED)
- AVOIDS END-OF-PIPE INCINERATION

OBJECTIVES OF RESEARCH

- DOCUMENT EMISSIONS AND CLAY / COAL USE REDUCTIONS IN FULL-SCALE FOUNDRIES
- WHAT ARE NANO-SCALE / FUNDAMENTAL REASONS WHY THIS WORKS?
- HOW CAN WE MAKE THIS WORK BETTER?

DOCUMENTATION AT FULL SCALE: NEENAH FOUNDRY

SAND PARAMETER	BEFORE AO	AO-STABLE	% Δ
CLAY + COAL ADD (LB / TON IRON)	187	125	-33
GREEN COMPRESSIVE STRENGTH (PSI)	33.3	34.6	+4
LOSS ON IGNITION (%)	5.44	3.65	-33
LOI / COAL ADDED (% / LB/TON IRON)	0.119	0.130	+10
GCS / CLAY ADDED (PSI / LB/TON IRON)	0.244	0.369	+51

DOCUMENTATION AT FULL SCALE: NEENAH FOUNDRY

EMISSIONS PARAMETER	BEFORE AO	AO STABLE	%Δ
NO-CORE VOC'S (LB / TON IRON)	0.60	0.22	-63
AVERAGE-CORE VOC'S (LB / TON IRON)	0.86	0.45	-47
VERY HEAVY CORE VOC'S (LB / TON IRON)	1.9	1.4	-26
NO-CORE BENZENE (LB / TON IRON)	0.055	0.030	-45

VOC EMISSIONS AT NEENAH FOUNDRY

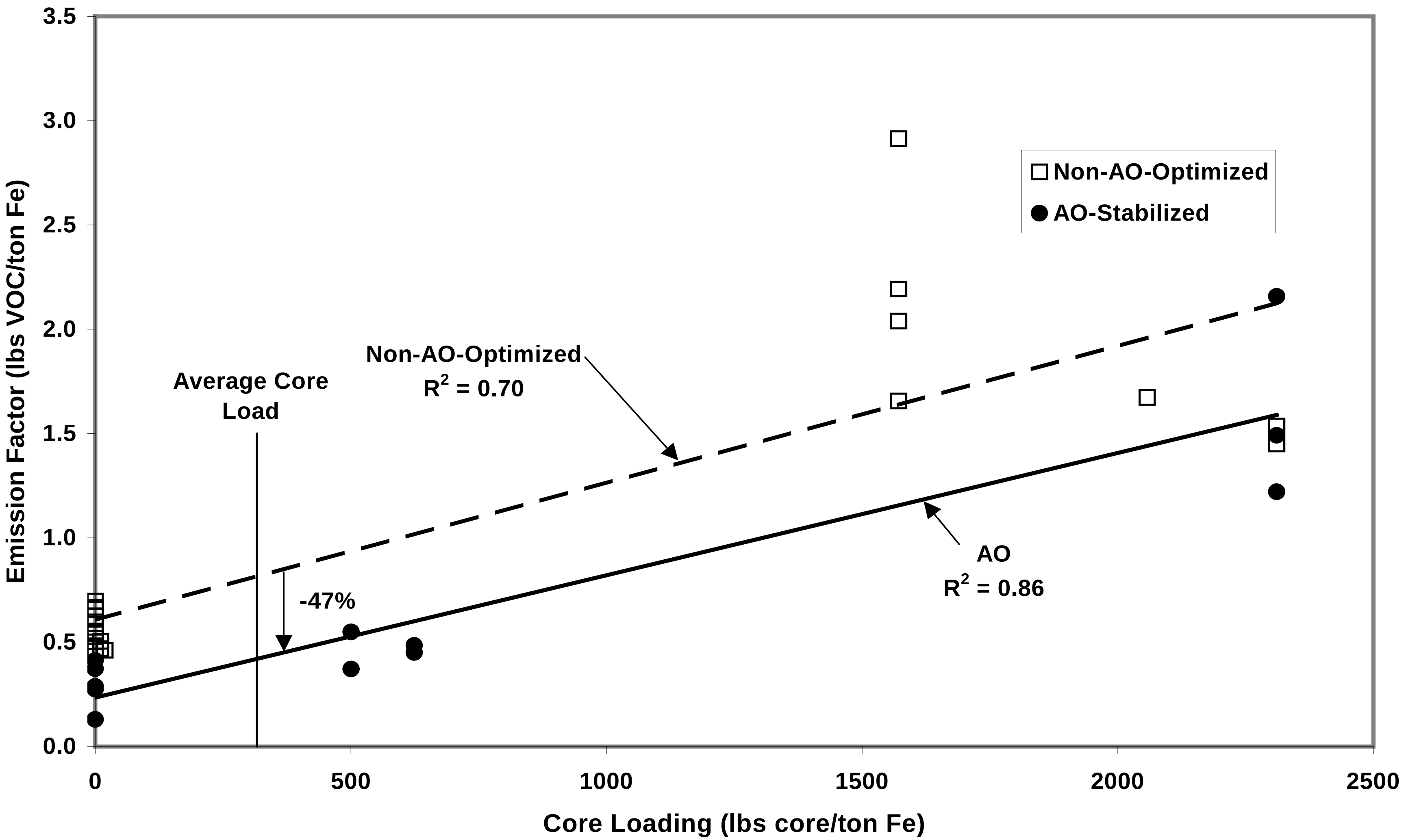
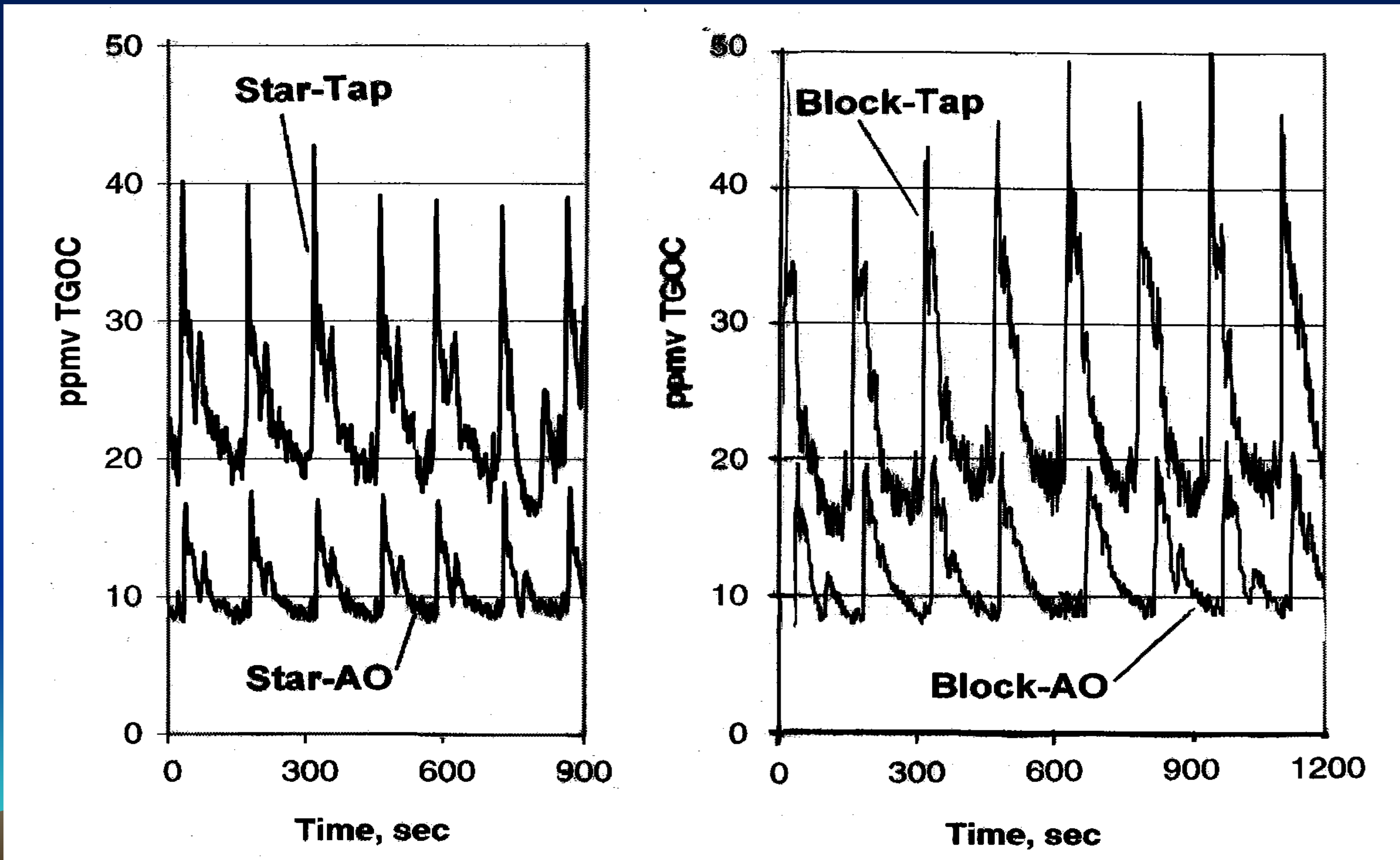


Figure 2 - Total Volatile Organic Compound (VOC) emissions performance during mold cooling plus shakeout: comparison of Non-AO-Optimized versus AO-stabilized sand systems at various core loadings

EMISSIONS AT CERP-TECHNICON
(IN COLLABORATION WITH PENN STATE)

EMISSIONS PARAMETER	NO AO	WITH AO	%Δ
NO-CORE LOI (%)	5.0	3.6	-28
NO-CORE VOC'S (LB / TON IRON)	0.52	0.19	-64
HEAVY CORE LOI (%)	4.62	3.07	-34
HEAVY CORE BINDER (LB / TON IRON)* (CONFOUNDED)	12.7	8.7	-31
HEAVY CORE VOC'S (LB / TON IRON)*	1.14	0.61	-46

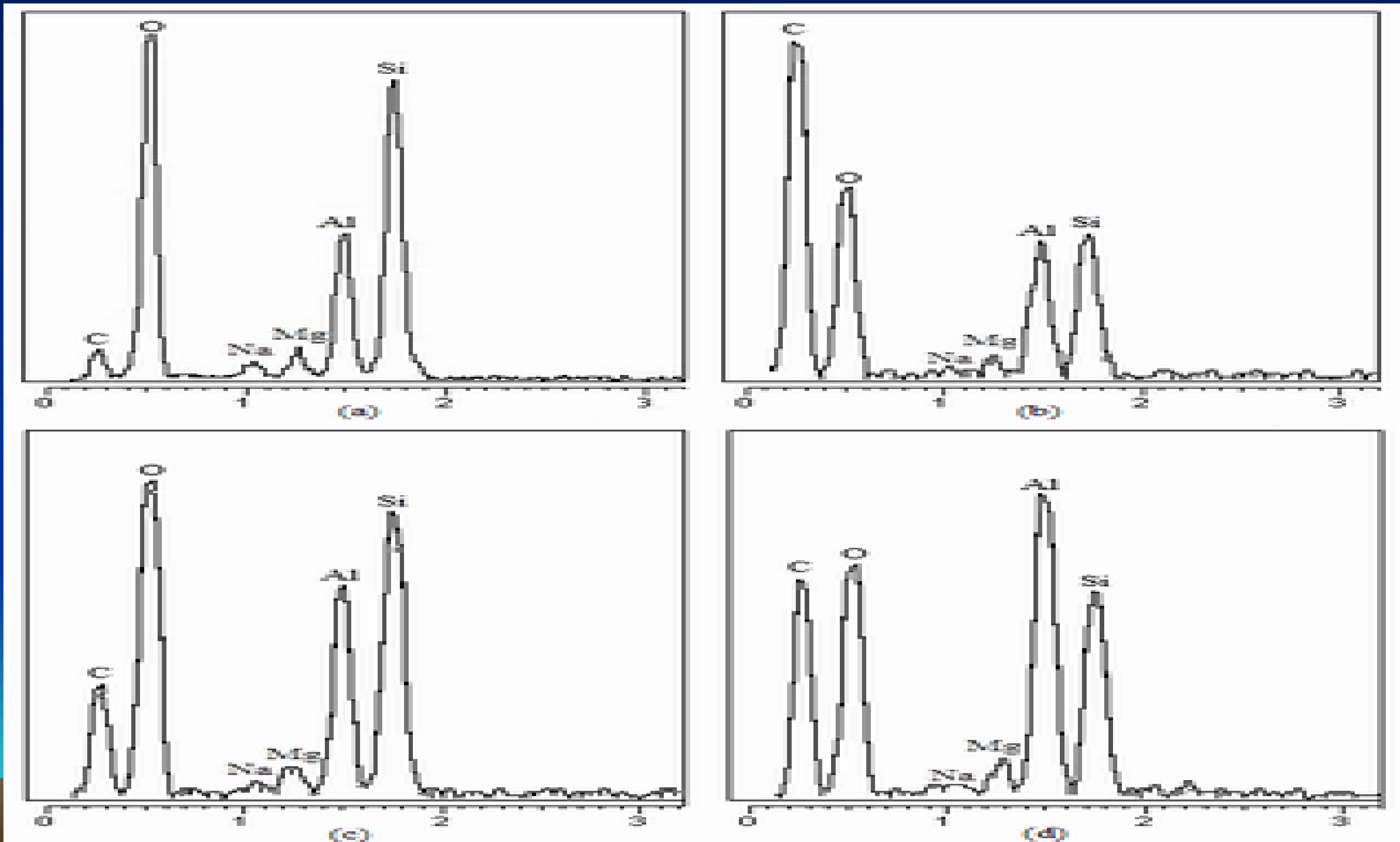
EMISSIONS AT CERP-TECHNICON
(IN COLLABORATION WITH PENN STATE)



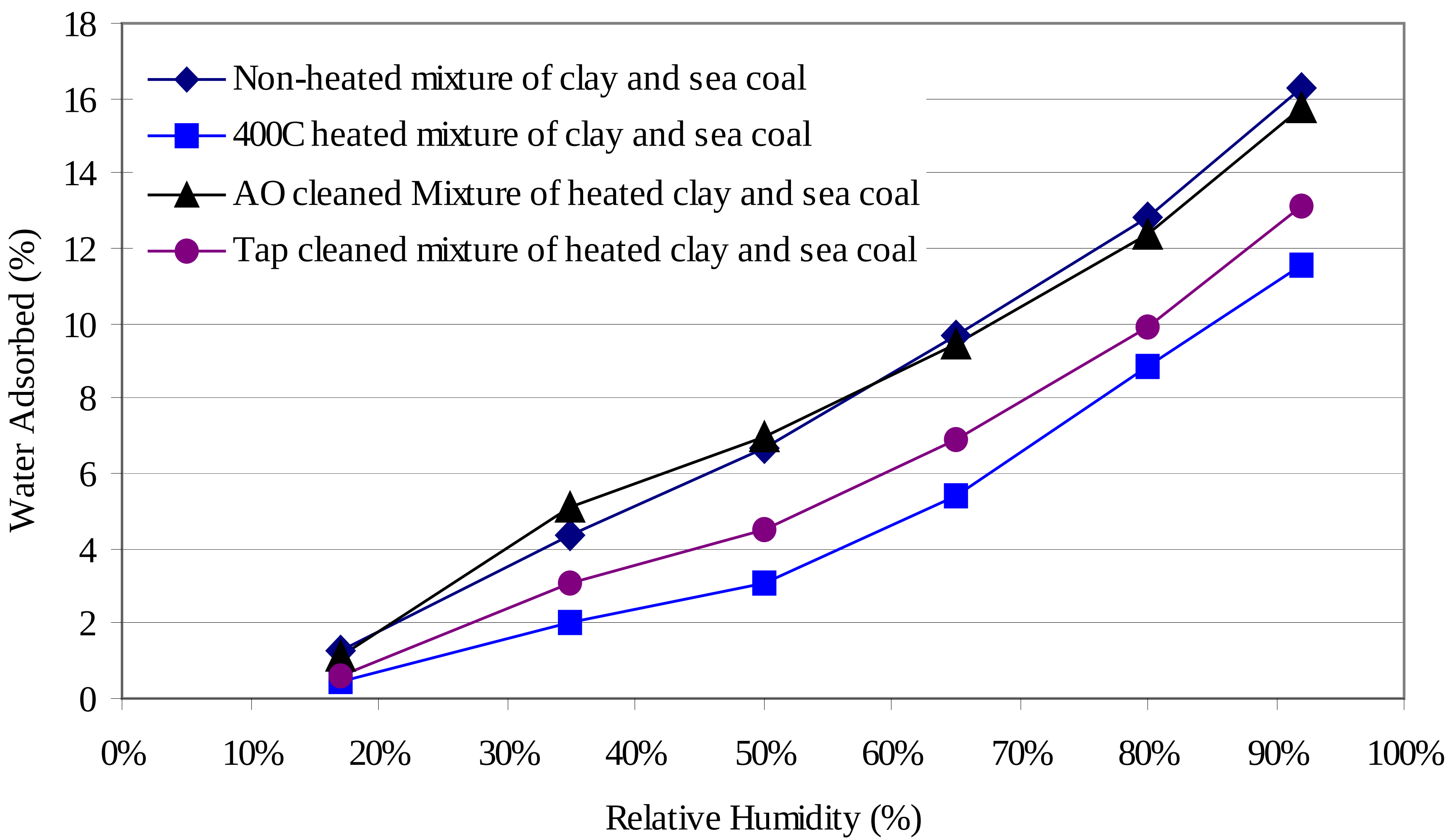
AT NANOSCALE, WHAT IS ADVANCED OXIDATION (AO) ACCOMPLISHING?

- CLAY PLATELETS LOSE CARBON COATING, SO HAVE MORE STRENGTH
- CLAY PLATELETS WITH AO CAN RETAIN WATER BETTER
- CLAY PLATELETS WITH AO HAVE SMALLER PARTICLE SIZE
- GREEN SAND WITH AO HAS MORE MICROPORES AND MESOPORES (CREATE ACTIVATED CARBON AS PP)
- GREEN SAND WITH AO CAN ADSORB ORGANIC COMPOUNDS BETTER (PP)

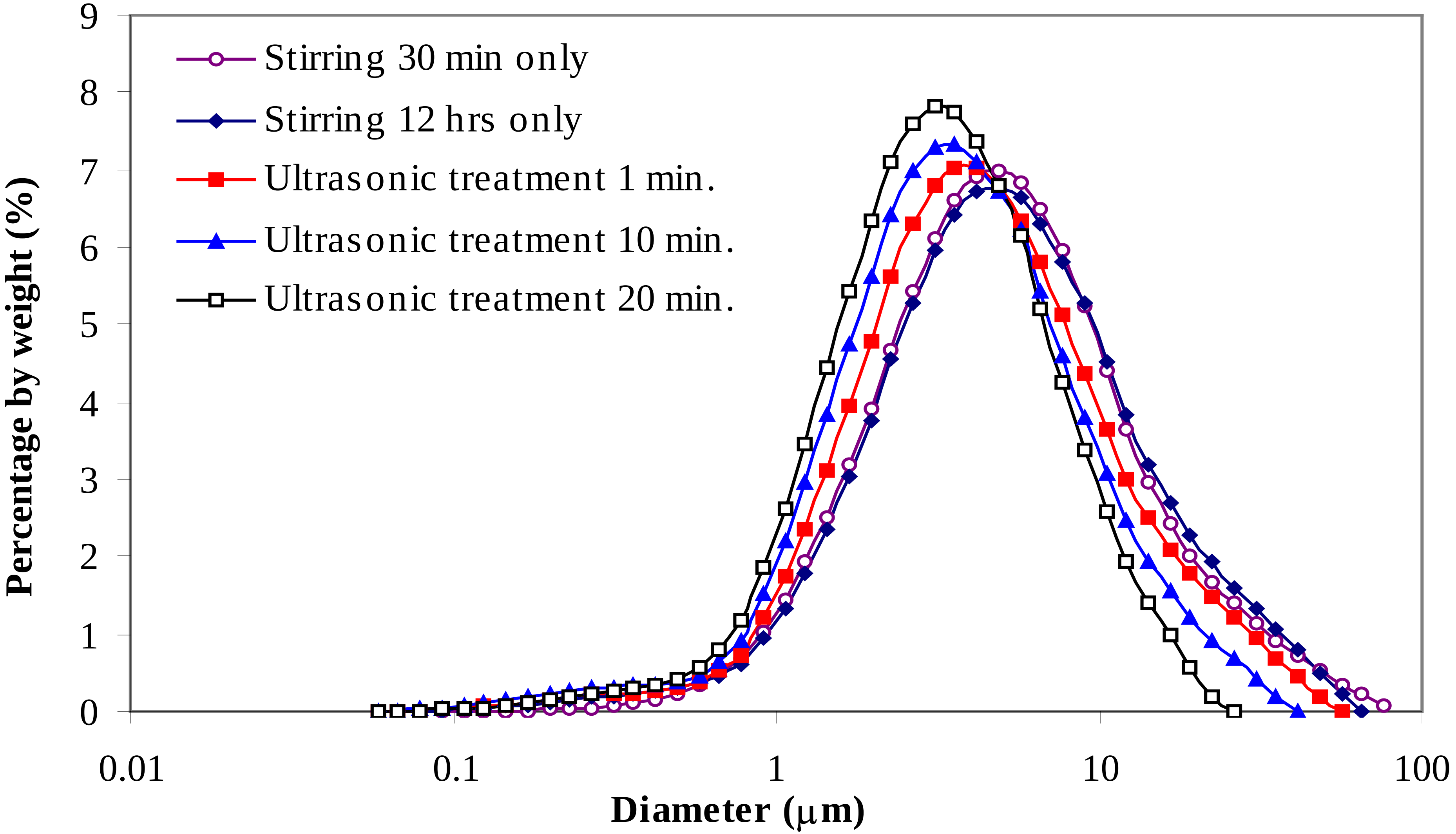
Surface elemental analysis of: (a) bentonite heated alone at 400ºC, (b) bentonite heated with sea coal at 400ºC, (c) AO–washed bentonite heated with sea coal at 400ºC, (d) TAP-washed bentonite heated with sea coal at 400ºC



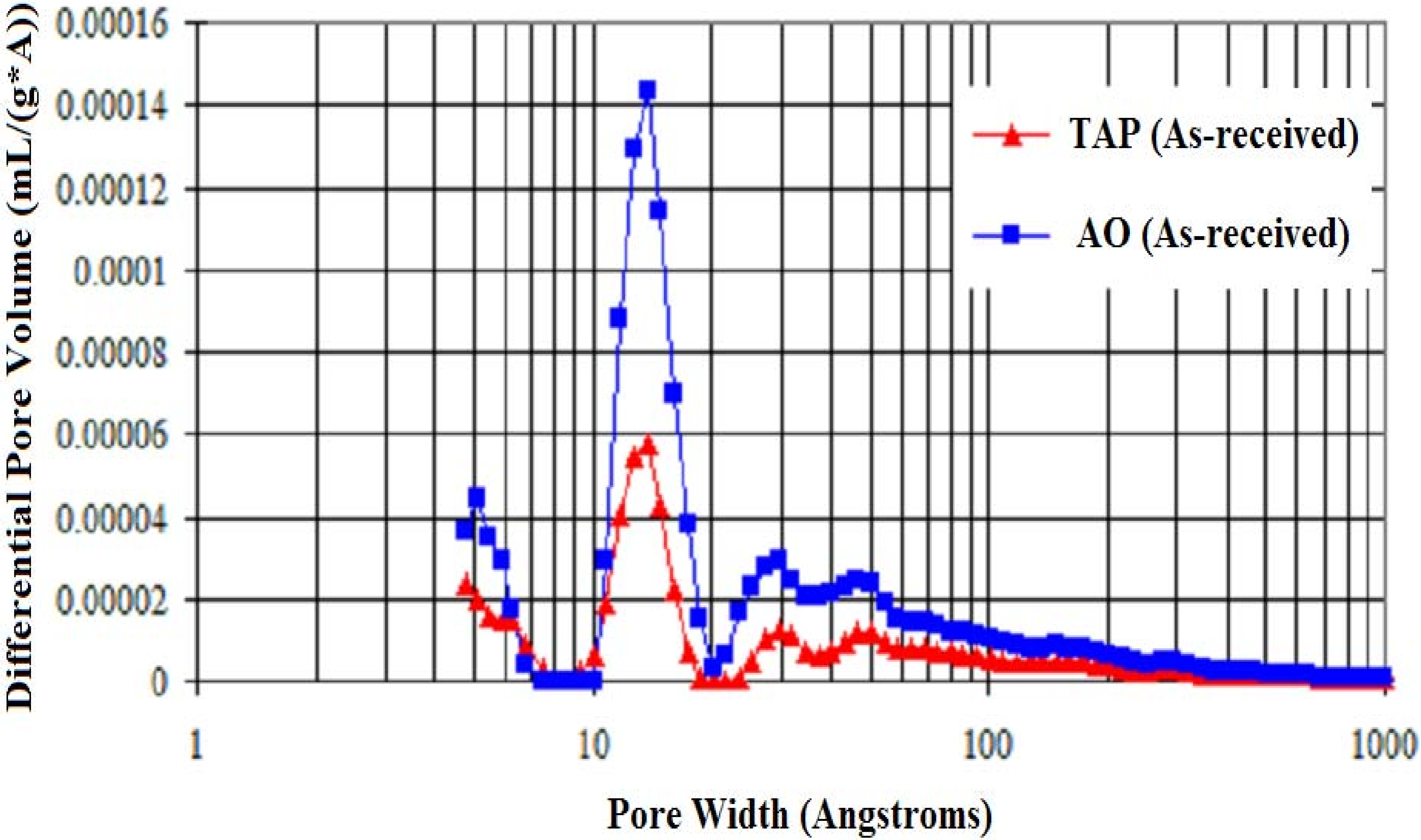
Water adsorption of: (a) bentonite heated alone at 400ºC, (b) bentonite heated with sea coal at 400ºC, (c) AO–washed bentonite heated with sea coal at 400ºC, (d) TAP-washed bentonite heated with sea coal at 400ºC



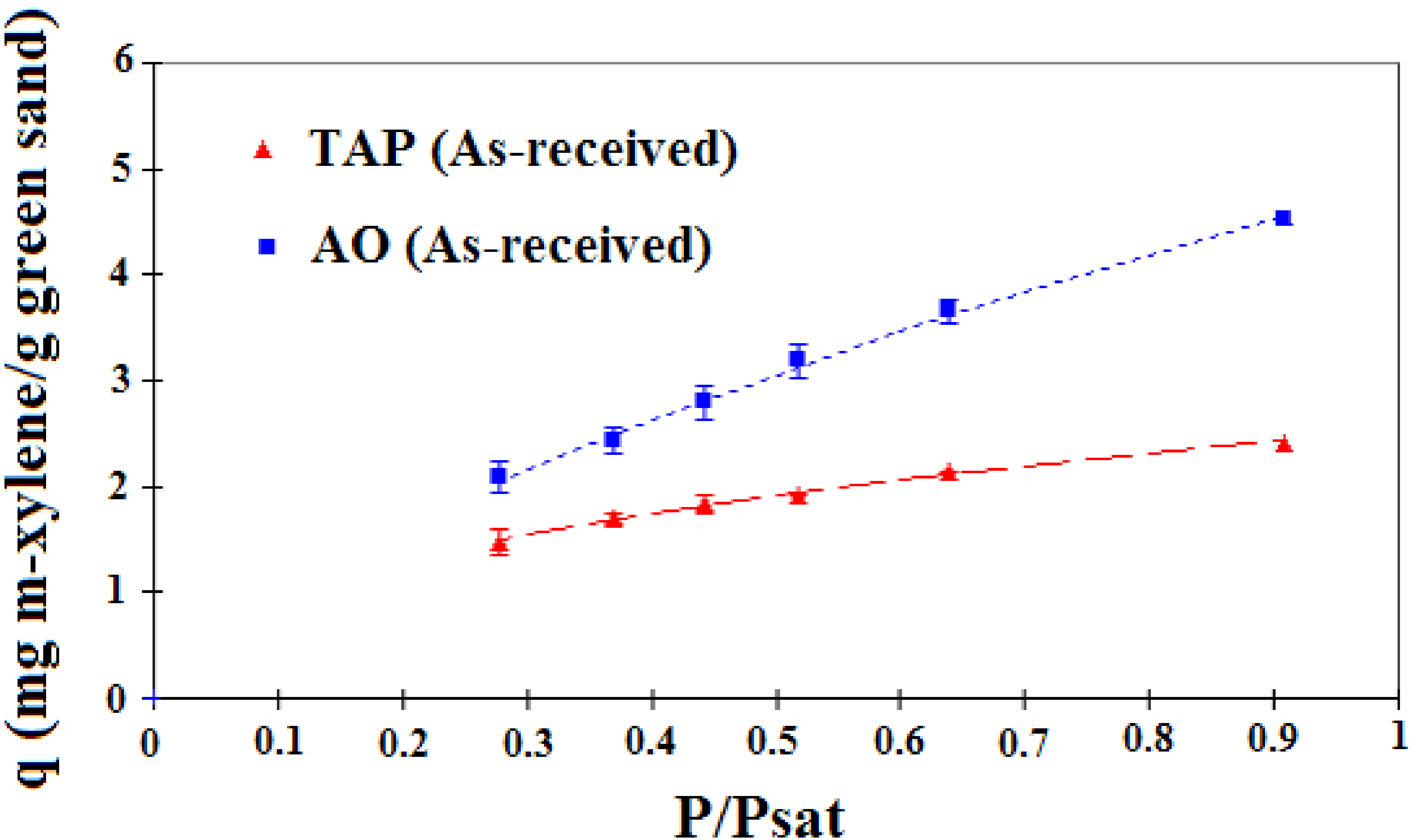
ULTRASONICS DIMINISHES CLAY PLATELET EFFECTIVE SIZE, SO MORE UNIT SURFACE AREA TO BIND (FROM 4.88 TO 3.08)



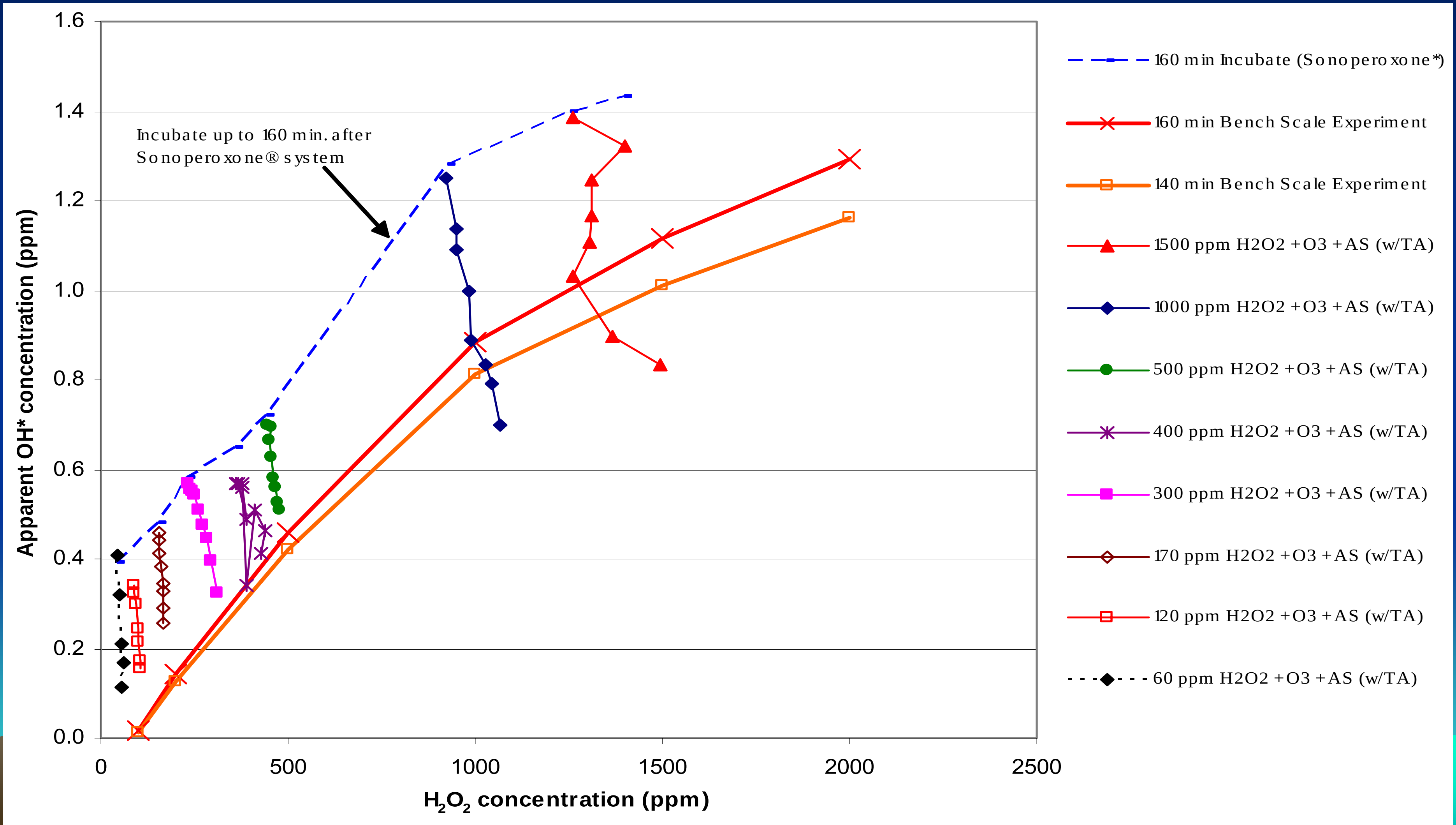
PORE VOLUME DISTRIBUTION



ADSORPTION CAPACITY OF META-XYLENE: AO VS. NON-AO



YIELD 0.4-1.4 PPM OH* WITH SONOPEROXONE™ (H_2O_2,O_3,SONIC)--BLUE. MORE THAN WITH JUST H_2O_2--ORANGE



WHAT CAN WE DO YET BETTER?

- MORE INTENSE AO?
- ADD UNDERWATER PLASMA? (START TEST WITHIN MONTH AT VICTAULIC)
- USE TREATED GREEN SAND AS AO ADSORBENT OF EMISSIONS DURING SHAKEOUT (IN SAND COOLER)
- GREEN SAND THAT HAS BEEN ONCE-EXPOSED TO 100-200oC RELEASES FAR FEWER EMISSIONS (DATA NOT SHOWN). INTEGRATE THIS INTO PROCESS

PENN STATE DELIVERABLES / INDUSTRY INTERACTION

- 5 REFEREED PAPERS PUBLISHED
- 1 REFEREED BOOK CHAPTER SUBMITTED
- 3 PAPERS TO BE SUBMITTED FOR REFEREED PUB. WITHIN A MONTH
- PSU STUDENTS AT FOUNDRIES FOR 3 STUDENT-SUMMERS
- MORE THAN 10 SITE VISITS TO FOUNDRIES
- >8 PRESENTATIONS AT AMERICAN FOUNDRY SOCIETY, EPA CONFERENCES
- >6 WORKSHOPS WITH FOUNDRY FOLKS

FOUNDRIES THAT USE SONOPEROXONE^{TM}

- Neenah Foundry (2 Lines)
- Grede-Reedsburg
- International Truck and Engine-Waukesha (2 lines)
- Gregg Industries
- Waupaca-Marinette
- Dalton Foundry-Warsaw (2ND LINE 8/04)
- CERP-Technicon
- Riverside Brass and Aluminum
- Victaulic Company of America-Alburtis
- Wescast Industries Inc.-Wingham (7/04)
- Wheland (2 lines-plant idle)