2004

AOA

AOA Core Modeling in Domestic Plants

,   ,   ,   ,   ,   ,   ,   ,   ,

493

AOA(Axial Offset Anomaly)

.

,

AOA

,   AOA   .

AO   ,   AOA

3   AOA

,   AO   0.1%   ,

AO   .

AO

.

Abstract

An axial offset anomaly(AOA) is generally defined as a significant negative axial offset deviation from predictions and is caused by the flux depression due to the boron compound precipitated in the crud which is accumulated in the upper portion of the fuel assembly. Plant operating condition in domestic plants has evolved in more harsh conditions with respect to AOA thus it is more likely that the domestic plants will experience AOA. In this paper, AO behaviors of domestic Westinghouse type plants were analyzed and the AOA core modeling using the virtual control rod is performed for three cycles which are believed to have experienced AOA and the amount of boron accumulated in the fuel assembly is estimated through the results of AOA core modeling. The AO modeled is within 0.1% of measured value and the assembly AO also agrees well with the measured one. Also it turns out that the boron accumulated is proportional to the integrated value of burnup weighted AO difference.

1.

AO (Axial Offset)   AOA

.   (Ni, Fe, Cr   )   (LiBO₂)
(Subcooled Boiling)

AOA   [1,2]. AOA

,

,   .

,

AOA   ,

AOA

.   AOA

AOA

AOA   .   AOA

AOA   .

AOA

,   ,

,

AOA   .   AOA   AOA

, AOA

.

8

INCORE[3]

AOA   AOA   3D
ANC[4]   AO   AO

AOA

.

2.   AO   AOA

2.1   AO

AOA   ,

                    .   ,   , 1

        ,   .

                  AOA

      ,   AO   AO

    AOA   .   AO

              ,   AO

  AOA   ,   AOA

    2%   AO   .

     AOA

                   AO

.   ,   31 EFPD   . AO

       8   42
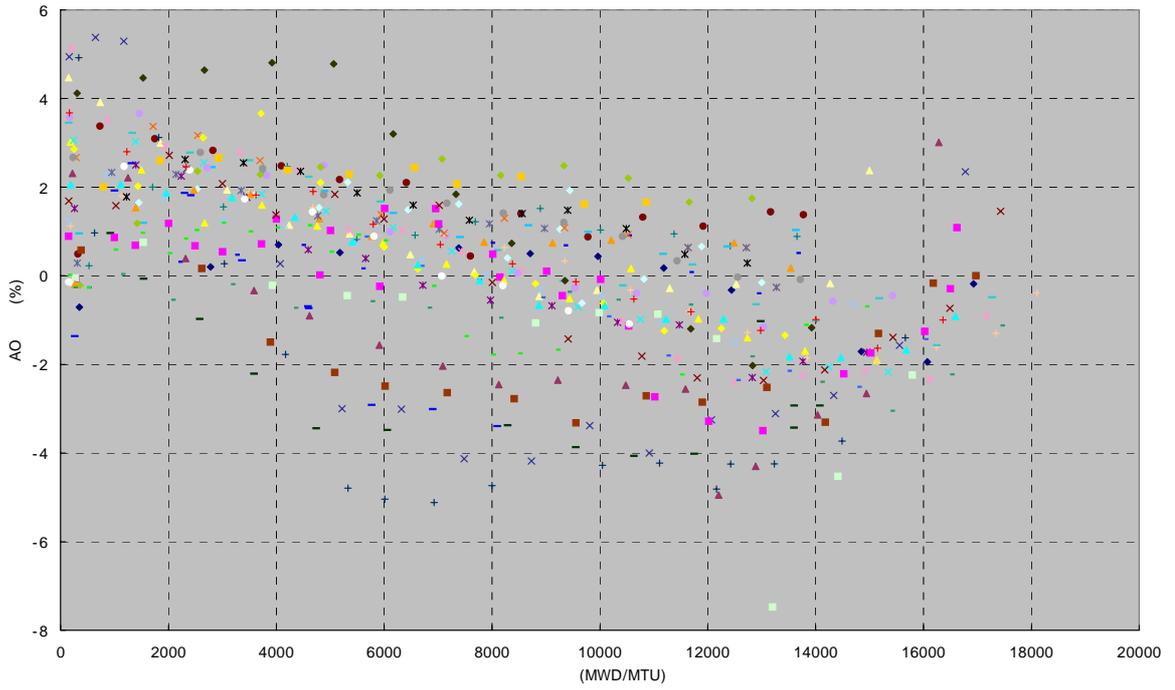
,   AO   AOA

        [5].

   1   AO   . AO

            - 3%   3

AOA   .

1.　　　　　　　　　　　　　　　AO

2.2 AOA

AOA　　　　　　　AOA　　　　　　　　　　　　　　　　AOA

　　　　　　　　　　　　　　　　　　　　　　　　,

　　　　　　　　　　　　　　　　　F_Q

　　　　　.　AOA

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[1,2].

　　AOA

　　　　AOA　　　　　　　　, 3D ANC　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　　　　　　　　　　　　　　,

AO　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　.

AOA　　　　　　　　　　　　　　　　　　　　2

　.

　　　) AOA　　　　　　　　　　　　　　4　　　　　7　　　　　　　(

　　84 inch ~ 138 inch)　　　　　　　　　　　　　.

.   6

,

.

) AOA   .

,

.

,

. AOA

.

.

)   AOA   .

AOA   AOA   .
AOA   AOA   .

) AOA   AO   AO

,   4000~5000 MWD/MTU   .   AO

AOA   .   AOA
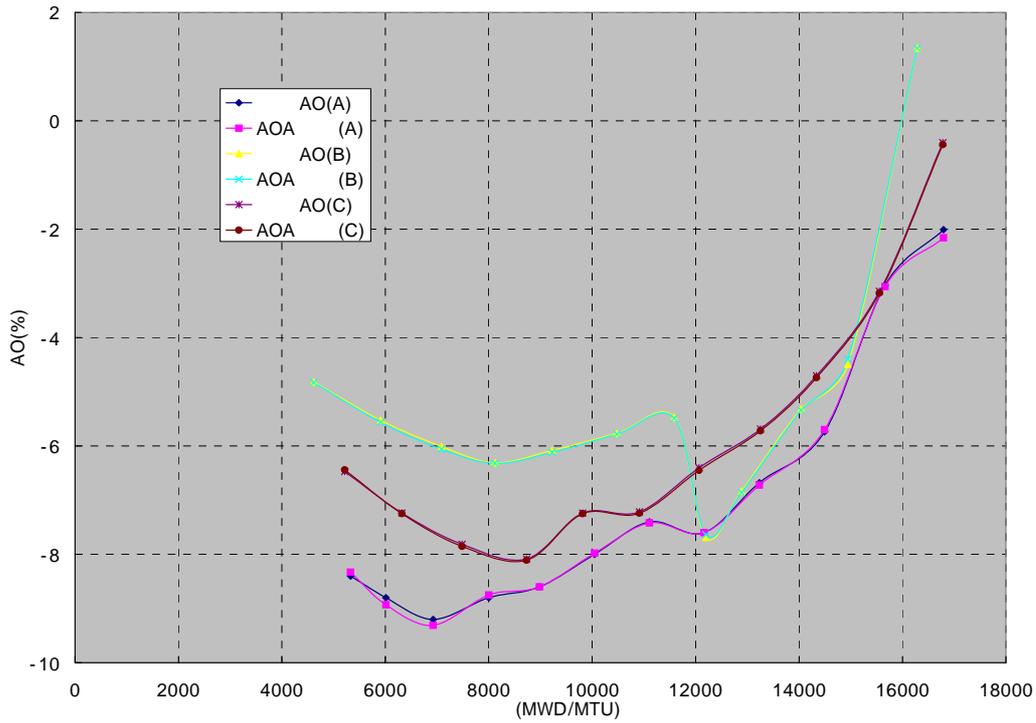
AO   3%   ,

2%

.

2   IFM(Intermediate Flow Mixer)   AOA

4   7

.

.

2. AOA   (IFM)

     AOA   AO
AOA   AO
      . AOA   3   .

     1. AOA

		A		B		C	
AOA		1	2	1	2	1	2
AOA		20	16	28	12	16	20
AO (%)		- 5.1		- 4.9		- 4.1	

                                                   AO

AOA   1   2   AO
          0.1%   .

                                                                              ,
                                    .

$$W_{B10+B11} = W_{B10} / wo_{B10}$$

$$W_{B10} = \frac{1}{6.022E23} \int_{V_{AOA\ ASSYS}} \Sigma_a^{adjusted} / \sigma_a^{B10}\ dv \times AW_{B10}$$

          ,
              $$wo_{B10} = 0.184$$
              $$AW_{B10} = 10.0$$

                                                                                        ,
B10   .
                                              AOA
              .

          3.

              AOA   AOA   AO
              3   .   AOA   AO   0.1%
5000MWD/MTU   AOA   .
AOA   (B)   12000 MWD/MTU   AO
              ,   ,
                          B10
                          .   4   AOA   (C)   8700 MWD/MTU
              AO   .   9
                      ,   AO   (NDR)
          –7.4%   AOA   –1.2%
          .

                                            .

3. AOA — AO

	H	G	F	E	D	C	B	A
8			−5.3 0.3	−5.0 −0.1	−4.5 0.0	−3.0 0.2	−2.3 0.2	−1.2 1.2
9		−7.4 −1.2	−5.2 0.0		−3.9 0.2	−3.1 0.0		−2.2 0.3
10			−7.0 −0.9	−4.9 0.1	−4.7 −0.2		−2.5 0.3	
11		−6.3 −0.5	−4.8 0.1	−5.8 −0.5		−2.6 0.5	−2.6 0.3	
12		−4.4 −0.3		−3.3 0.5	−2.7 0.8	−2.8 0.4		
13		−2.8 0.3	−3.5 −0.3		−2.1 1.1			
14		−1.6 0.9		−2.3 0.6			M−P(NDR) M−P(AOA)	
15								

4. AOA — AO (AOA (C) − 8700 MWD/MTU)

5 AOA (C)

. 5200 MWD/MTU
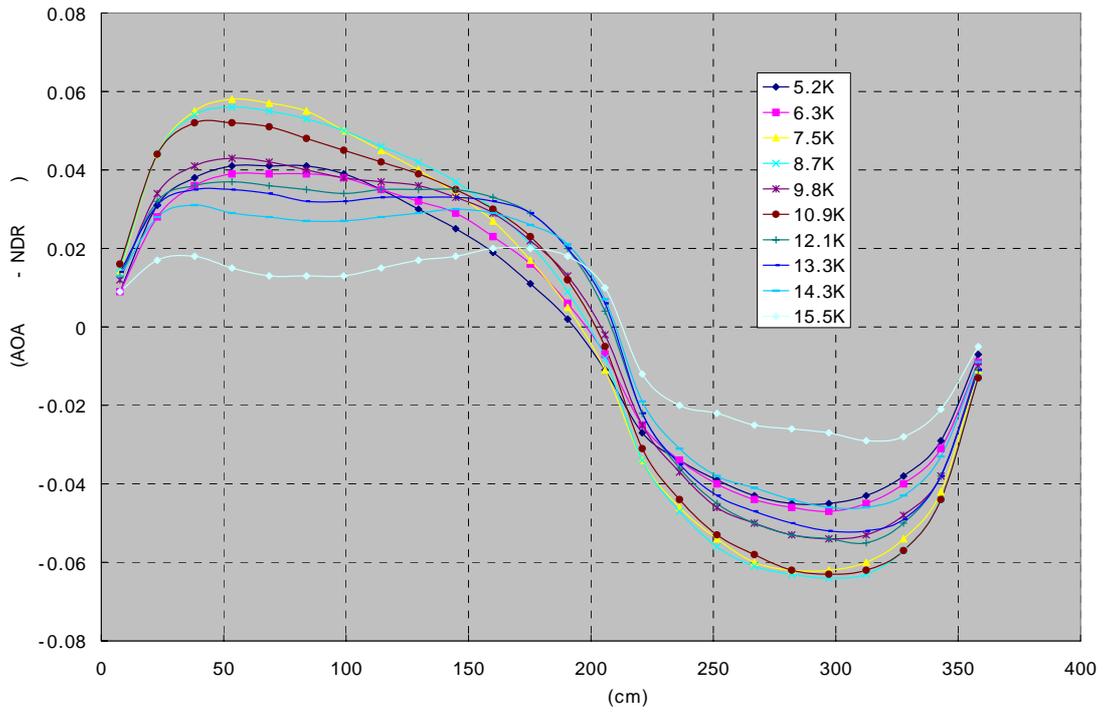
8700 MWD/MTU

AO

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5. AOA (C) NDR

6 AOA AO

AO AO

. AOA AO

.

AO .

pH 7.4 2.2 ppm

7.4 pH

(LiBO2) .

그림 6.   AO

AO   AOA

3   AO   AO

AOA   ,

AO   0.1%   ,   AO

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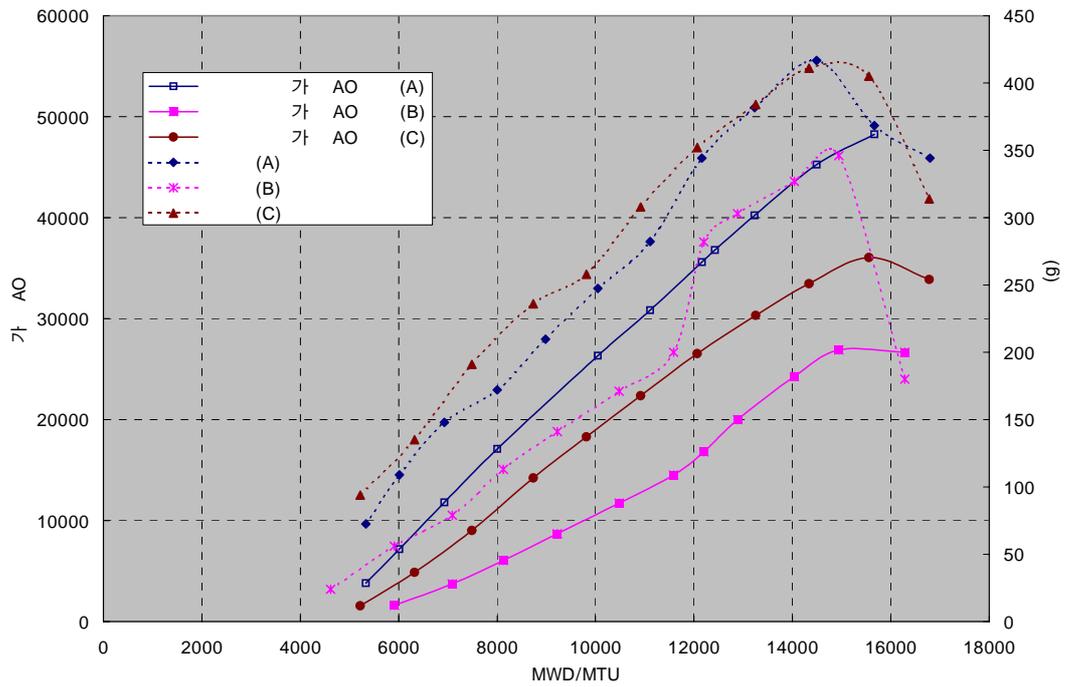
,   AO

.   AOA

.   AOA   AOA

AOA

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5.   , "   ,"   , 2002