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گروه: مهندسی اکتشاف معدن

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تقدیم بہ

آستان مقدّس امام رضا (ع)،

والدین عزیزم کہ دعایشان بدرقہ مسیر زندگی ام است،
خواهران و برادرم کہ امید بخش ویاورم ستند،

و

خواہر زادہ ما و برادر زادہ ہایم کہ لحظہ لحظہ بودن با آنها برایم شیرین است.

تقدیر و تشکر

اینک که به توفیق حق و در سایه تلاش و کوشش خویش توانستم دوره دکتری را با موفقیت به پایان برسانم بر خود وظیفه می دانم که: از زحمات جناب آقای دکتر فرامرزدولتی ارده جانی، استاد راهنمای محترم خود، که در راستای انجام تحقیق برای اینجانب محفل شدند تشکر و سپاس فراوان بنمایم. اخلاق نیکو و ادب ایشان در کنار آموزش های علمی، بیچگاه از ذهن اینجانب پاک نخواهد گردید. برای ایشان در تمامی عرصه های زندگی آرزوی موفقیت و سربلندی می نمایم.

از استادان مشاور آقایان پروفور راگو سینک و دکتر محمد رضا محوی که بنده را در انجام این تحقیق یاری کردند سپاسگزارم. از شرکت ملی فولاد و مدیران محترم طرح بهمن معدن آهن سگان آقایان مهندس خوانساری و مهندس امیری به خاطر مساعدت ایشان و همچنین پرسنل محترم معدن کمال تشکر و سپاسگزاری را دارم.

از اساتید محترم دانشکده مهندسی معدن دانشگاه صنعتی شاهرود که در طول تحصیل بنده ریا یاری رسانند، سپاسگزارم. از ریاست محترم دانشگاه صنعتی شاهرود، جناب آقای دکتر علی مرادزاده که زمین دیدار اینجانب با مقام معظم رهبری را در دیدار ایشان با دانشجویان در سال ۸۵ فراهم کردند، سپاسگزارم.

از جناب آقای دکتر محمد جواد شیرکیو و خانواده محترم ایشان که بنده را در طول تحصیل یاری کردند، کمال تشکر را دارم. از تمامی دوستان عزیز خودم بویژه آقایان حسین میرزایی نصیر آباد، حمید جهانشاهی، عباس مسگری و ش، مهندس محمد یعقوبی پور، رضا سکور شهبانی، محمد کاراموزیان و خداکرم غریبی که لحظات شیرینی را با آنها در طول زندگی خوابگاهی و بعد از آن تجربه کردم، سپاسگزارم.

از هم کلاسی های خودم آقایان حمید آقا جانی، مرداد سلیمانی و علیرضا عرب امیری که هم اندیشی آنان سبب ارتقای دانش علمی اینجانب گردید، سپاسگزارم.

از پرسنل محترم آموزشی، اداری، فرهنگی و خدماتی دانشگاه صنعتی شاهرود بالانص پرسنل محترم دانشکده معدن کمال تشکر و سپاسگزاری را دارم.

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SEEP/W

(Singh and Atkins, 1985)

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PHOENICS

دانشجو تأیید می نماید که مطالب مندرج در این رساله نتیجه تحقیقات خودش می باشد و در صورت استفاده از نتایج دیگران مرجع آن را ذکر نموده است.

کلیه حقوق مادی مترتب از نتایج مطالعات ، آزمایشات و نوآوری ناشی از تحقیق موضوع این رساله متعلق به دانشگاه صنعتی شاهرود می باشد .

احمد آریافر

تیرماه ۱۳۸۸

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(Doulati Ardejani et al., 2003)

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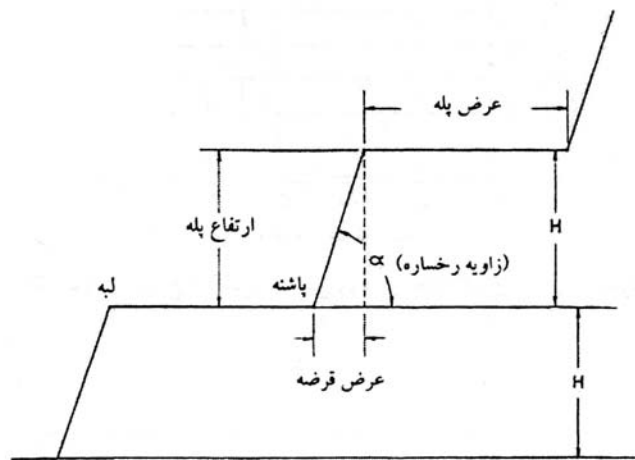
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(Naugle and Atkinson, 1993)

(Reed, 1986)

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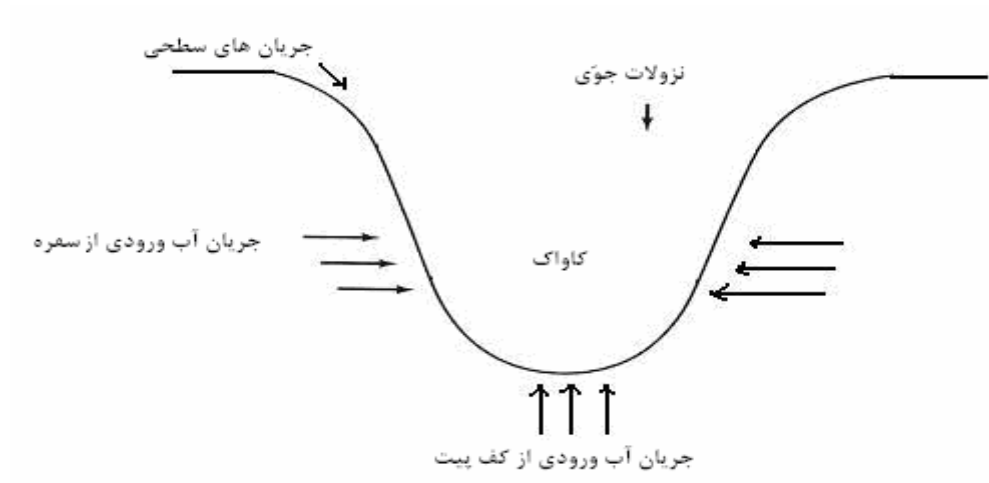
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:(Bohnet and Kunze, 1990)

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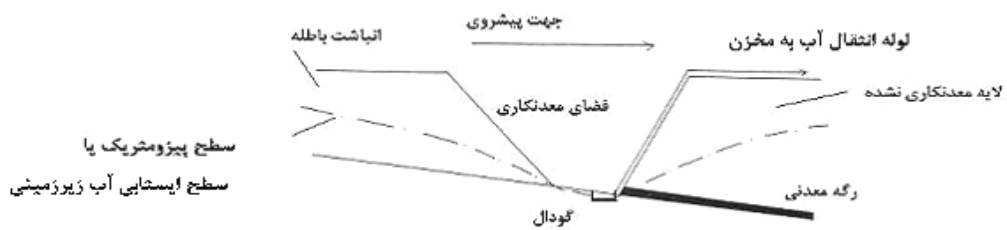
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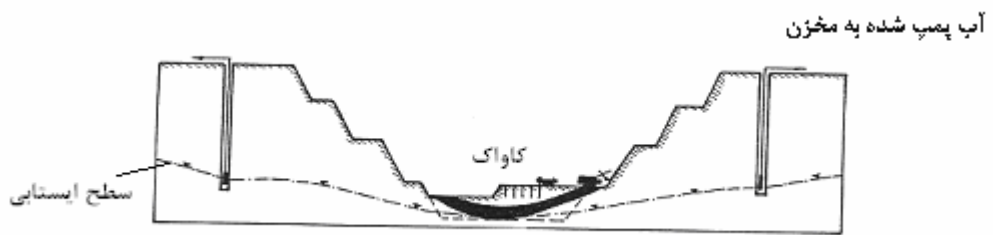
(Reed and Singh, 1986)

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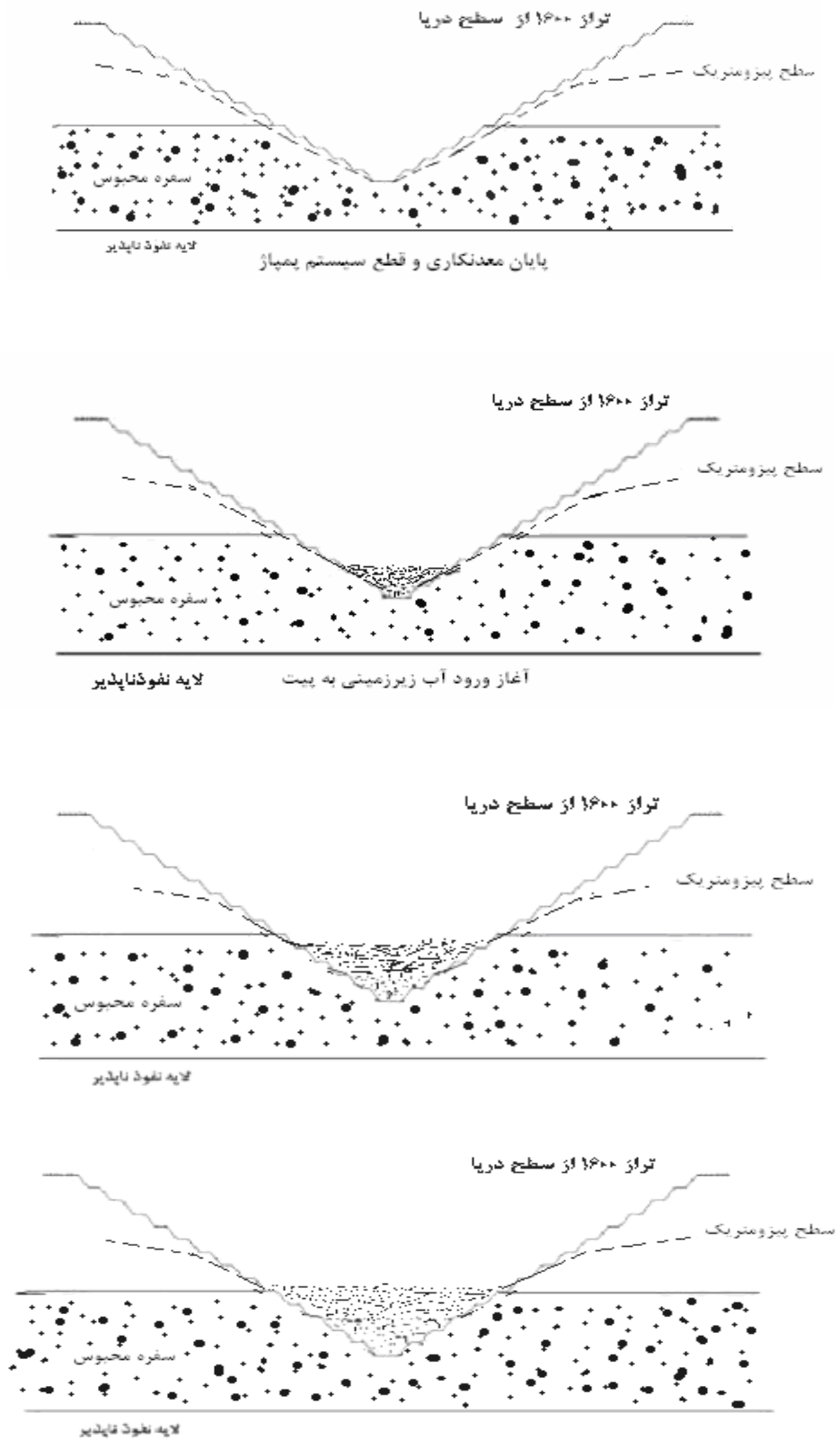
(Norton, 1983)

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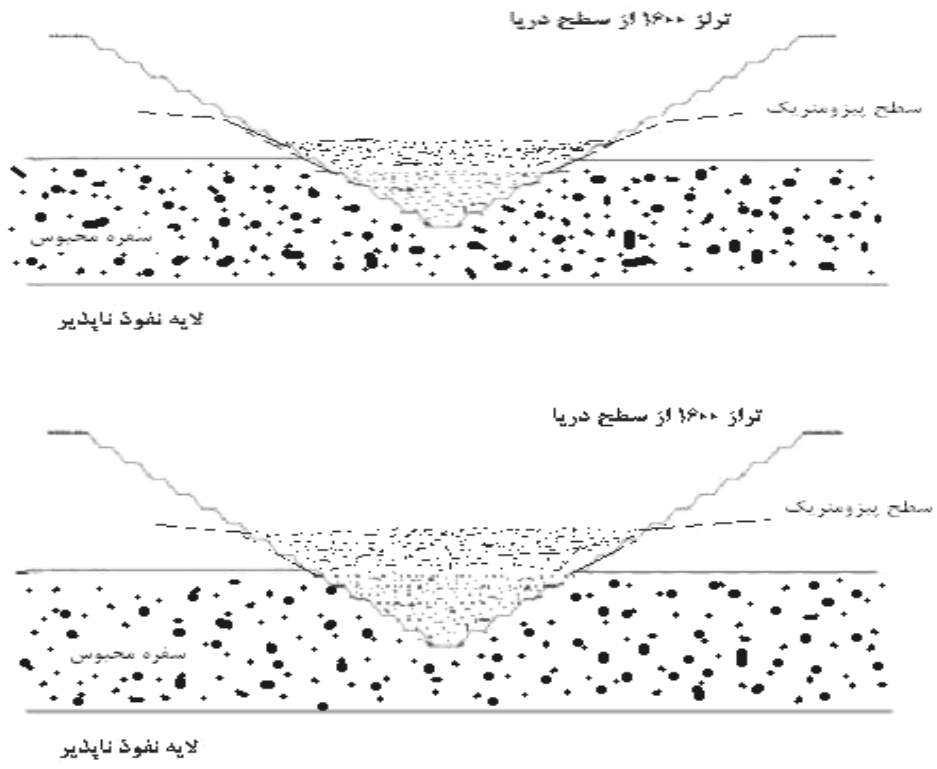
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(Norton, 1983).

(Bohnet and Kunze, 1986).

(Norton, 1983).

(Doulati Ardejani *et al.*, 2006). اجرای

(Shevenell, 2000).

(Doulati Ardejani,)

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Singh and Reed,)

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⁴ Equivalent well approach model
⁵ Two dimensional model
⁶ Hofedunk

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⁹ Rubio and Lorca

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¹³ Passive

¹⁴ James and Barrette

¹⁵ Kip

¹⁶ Niccoli and Marinelli

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¹⁷ Bochenska

¹⁸ White

¹⁹ Geoslope international

²⁰ Ground Penetrating Radar

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²¹ Keqiang

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(Davis and Zaboloteny, 1996

(Henton, 1981)

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(Shevenel, 2000 ;Vanderluis *et al.*, 1995 ;Naugle and Atkinson, 1993)

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²⁵ Davis

²⁶ Kempton

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²⁷ Richard and McNulty
²⁸ Spreed sheet
²⁹ Gardiner

(Doulati Ardejani et al., 2003, 2004, 2005, 2006)

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³⁰ McCullough

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Cu^{2+} Zn Cu Ni Co Fe Ca Mg K Na
Cr Hg Cd Pb As

(Magdalena, 2005)

(AMD)

Davis and (Davis, 1983 Cathles, 1979 Cathles and Apps, 1975)

(Lefebvre and Gelinas, 1995 Davis et al., 1986 Ritchie, 1986a

Walter *et al.*, 1994b Walter *et al.*, 1994a Elbering *et al.*, 1994)

(Wunderly *et al.*, 1996 Bridwell and Travis, 1995

(Rogowski *et al.*, 1997; Jaynes *et al.*, 1984a, b)

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³¹ Pantelis and Ritchie

³² Farrel

³³ Arnoldi

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³⁴ Frostad

³⁵ Yilmaz and Atmaca

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³⁶ Computational fluid dynamic

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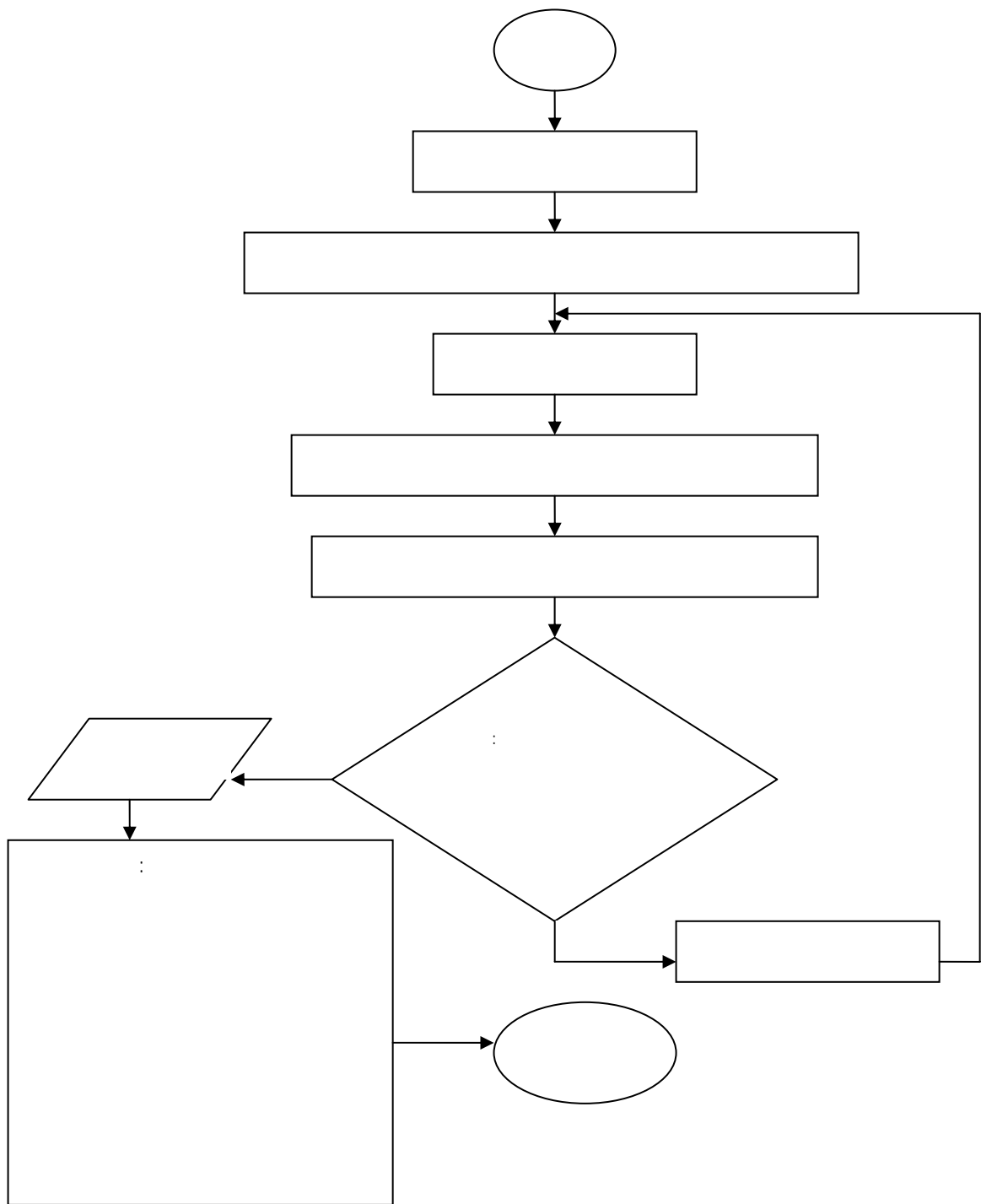
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Singh and Atkins,)

(1985

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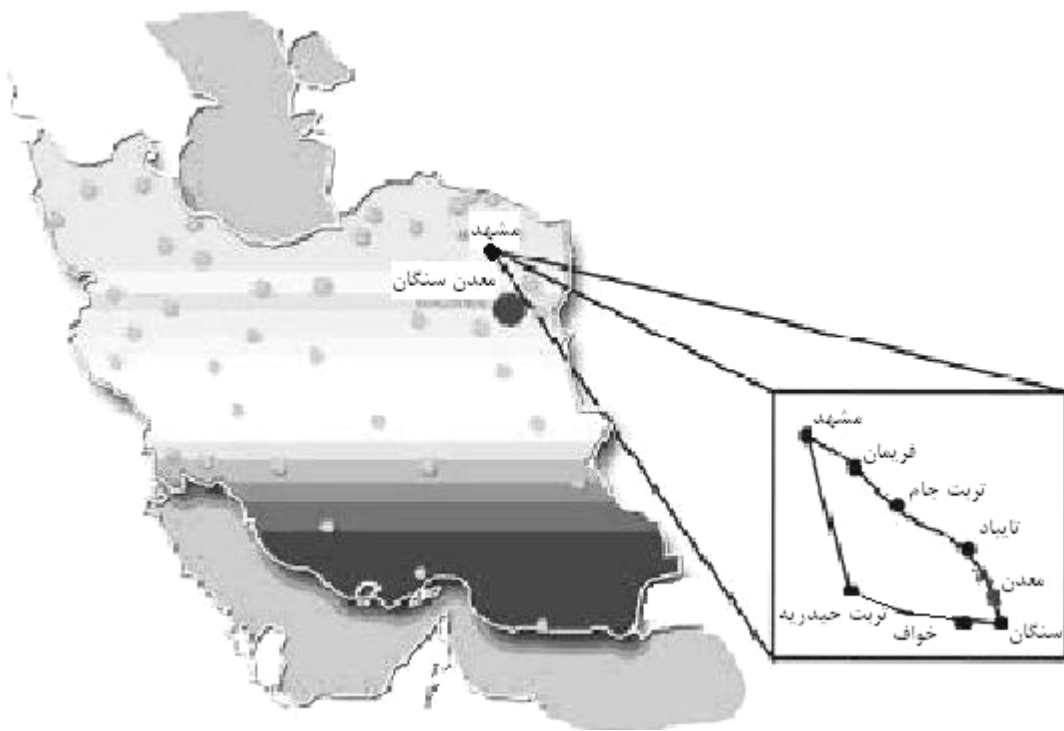
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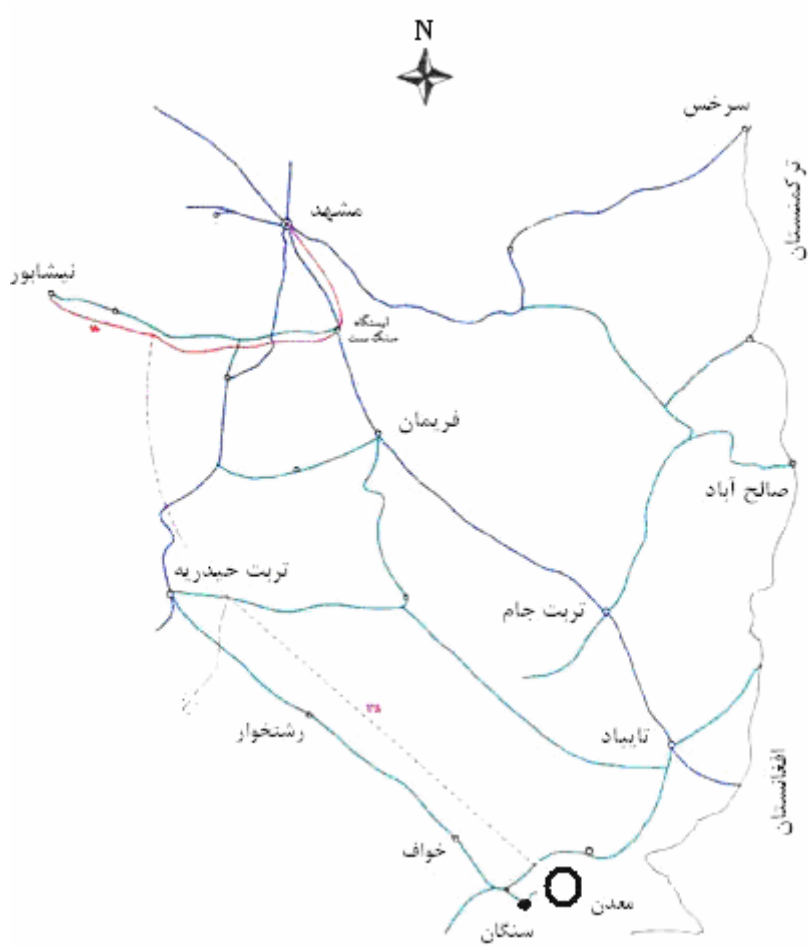
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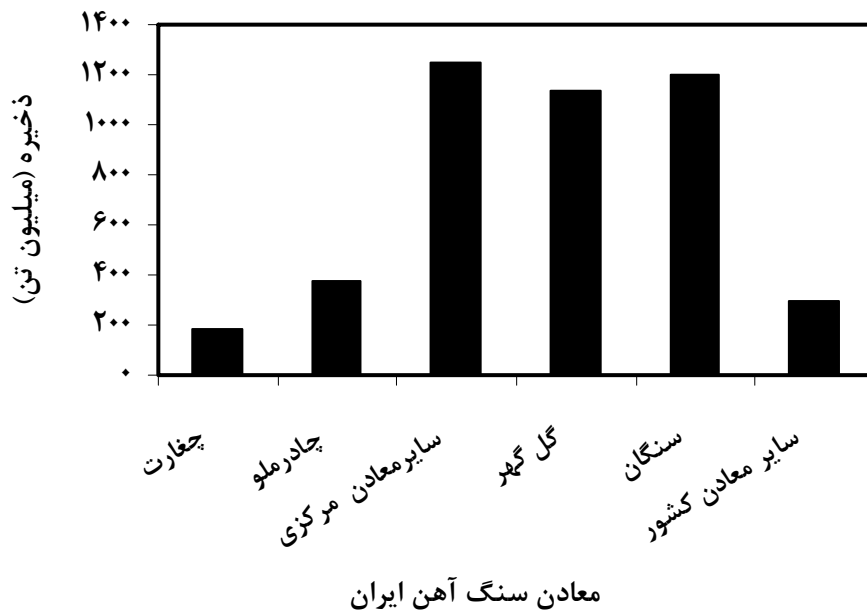
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۵۲۸	۵۷۳	۰۰۱۲		
۰۰۲	۰۰۱	۳۰۰		
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معادن سنگ آهن ایران

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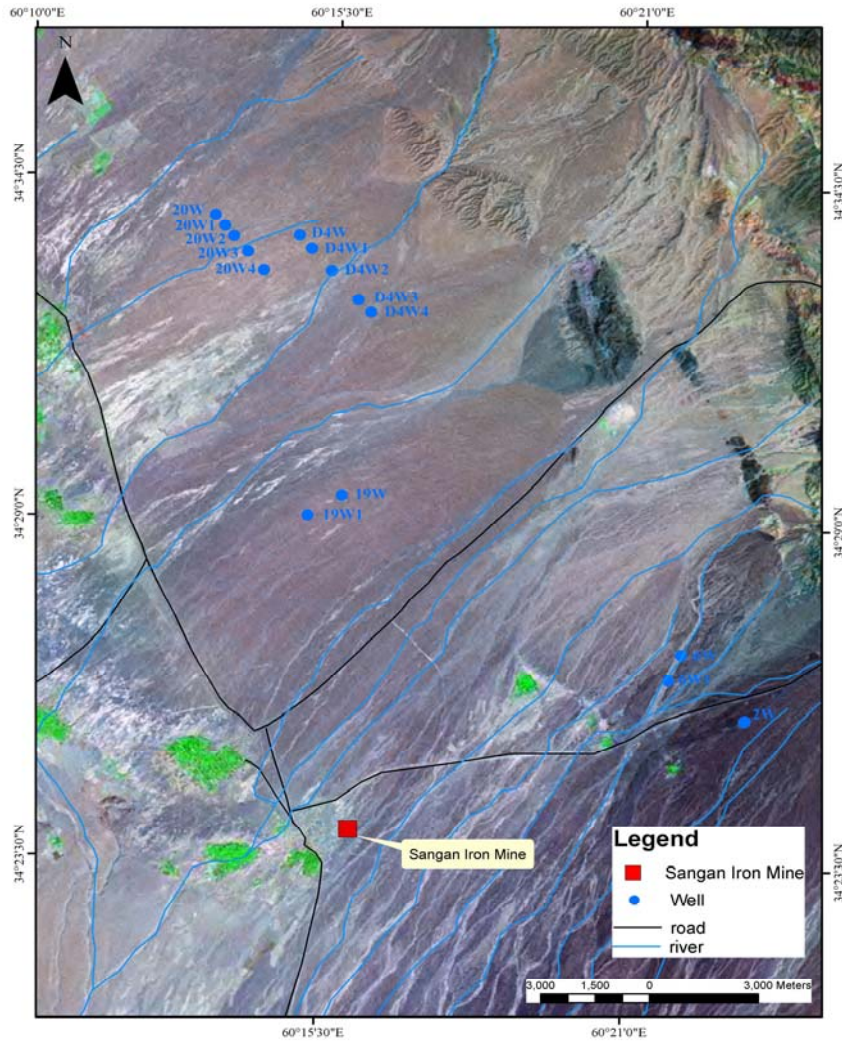
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D4W	·/·۳۲۷	۶۶	·/·۰۰۰۰۳۰۹	۲۶/۱۸	۱۷۳۰/۹۶
D4W1	·/·۳۵۸	۶۶	·/·۰۰۰۰۷۸۴۹	۲۳/۴۱	۱۵۴۸
D4W2	·/·۳۵۳	۶۶	·/·۰۰۰۳۸۵	۲۱/۹۵	۱۴۴۸/۷۹
D4W3	·/·۳۷۲	۶۶	·/·۰۰۲۷	۲۵/۹۲	۱۷۱۰/۸۴
D4W4	·/·۳۹۱	۶۶	·/·۰۰۵۱۹	۲۶/۷۸	۱۷۶۹/۳۵
20W	·/·۴۷۲	۱۰۸	·/·۰۰۰۰۱۶	۱۸/۸۴	۲۰۳۴/۱۴
20W1	·/·۴۷۲	۱۰۸	·/·۰۰۰۰۶۴	۱۲/۹۶	۱۴۳۵/۸۵
20W2	·/·۴۷۲	۱۰۸	·/·۰۰۰۰۲۹	۱۲/۵۷	۱۳۵۷/۵۳
20W3	·/·۴۵۵	۱۰۸	·/·۰۰۰۱۳۷	۵/۲۷	۵۶۷/۱۶
20W4	·/·۴۶۱	۱۰۸	·/·۰۰۰۰۲۵	۱۶/۸۵	۱۸۲۲/۶۸
6W	·/·۴۷۷	۸۳	·/·۰۰۰۰۳۷	۶/۰۵	۵۰۳/۶۲
6W1	·/·۵۱۴	۸۳	·/·۰۰۰۰۱۶	۵/۰۱	۴۱۸/۸۳
2W	·/·۳۶۱	۴۳	·/·۰۰۰۰۲۷۸	۸/۰۴	۳۴۳/۹۵
2W1	·/·۳۶۱	۴۳	·/·۰۰۰۰۲۷۸	۸/۰۴	۳۴۳/۹۵
19W	·/·۱۸۵	۸۶	·/·۰۰۱۷۷	۱۲/۷۰	۱۰۹۶/۹
19W1	·/·۱۸۵	۸۶	·/·۰۰۳۲۷	۱۲/۷۰	۱۰۹۶/۹

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SEEP/W

(Freeze and Cherry, 1979)

$$\frac{\partial}{\partial x} \left(K_x \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_y \frac{\partial h}{\partial y} \right) = C \frac{\partial}{\partial t} (h) + Q \quad ()$$

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$$\frac{\partial \theta}{\partial t} = C \frac{\partial h}{\partial t} \quad ()$$

SEEP/W

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$$L(h) = \frac{\partial}{\partial x} \left(K_x \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_y \frac{\partial h}{\partial y} \right) - C \frac{\partial}{\partial t} (h) - Q = 0 \quad ()$$

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³⁷ Galerkin approach

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(Pinder, 1972)

$$h \approx h(x, y, t) = \sum_{i=1}^n h_i(t) N_i(x, y)$$

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i : $h_i(t)$

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: $N_i(x, y)$

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$$L[h(x, y, t)] = R$$

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: (Pinder, 1972)

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$$\int_D RW_i dD = 0 \quad i=1,2,\dots,n$$

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D : W_i

: (Pinder, 1972)

L(h)

$$\iint L[h(x, y, t)] N_i(x, y) dx dy = 0 \quad i=1,2,3,\dots,n$$

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. D n h $h_i(t)$

³⁸ Trial solution

³⁹ Shape function

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$$[G]\{h\} + [H]\left\{\frac{dh}{dt}\right\} + \{F\} = 0 \quad ()$$

. n n n [H] [G]

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$$G_{ij} = \iint_D \left[K_x \frac{dN_i}{dx} \frac{dN_j}{dx} + K_y \frac{dN_i}{dy} \frac{dN_j}{dy} \right] dx dy \quad ()$$

$$H_{ij} = \iint CN_i N_j dx dy \quad ()$$

:(Pinder, 1972) {F}

$$C_i = - \iint_D Q N_i dx dy - \int_{\beta} N_i \sum_{j=1}^n \left[K_x \frac{dN_j}{dx} l_x + K_y \frac{dN_j}{dy} l_y \right] h_j d\beta \quad ()$$

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$$\Delta h = \frac{Q}{4\pi T} W(u) \quad ()$$

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: $W(u)$

$$u = \frac{r^2 S}{4Tt} \quad ()$$

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(Krusman and De

$$u < 0.01$$

Reeder, 1990)

$$\Delta h = \frac{Q}{4\pi T} \left(\ln \frac{2.25 Tt}{r^2 S} \right) \quad ()$$

(Krusman and De

Reeder, 1990)

$$\Delta h' = \frac{Q}{4\pi km} \left\{ \ln \left(\frac{4kmt}{r^2 S} \right) - \ln \left(\frac{4kmt'}{r^2 S'} \right) \right\} \quad ()$$

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:t'

⁴⁰ Residual drawdown

$:S'$

$:m$

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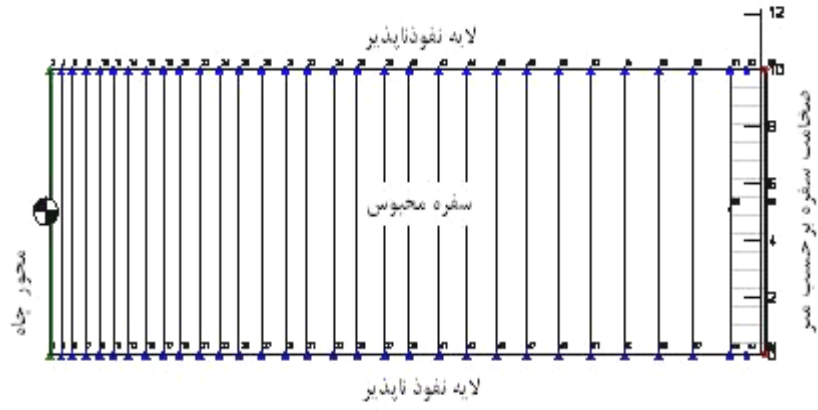
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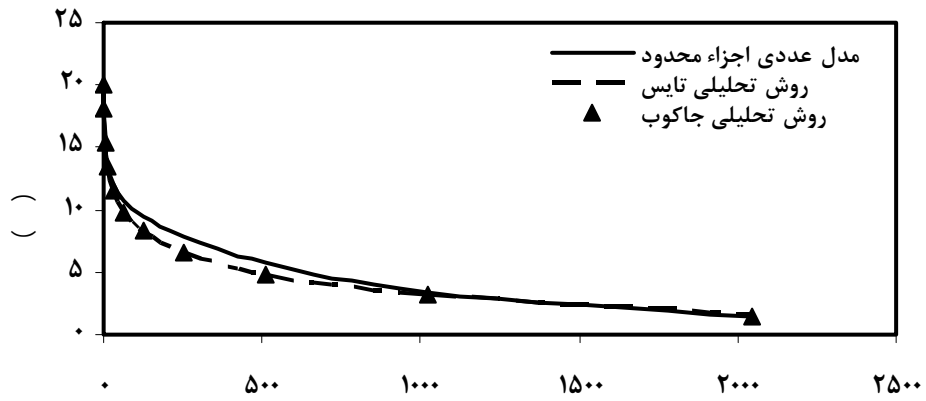
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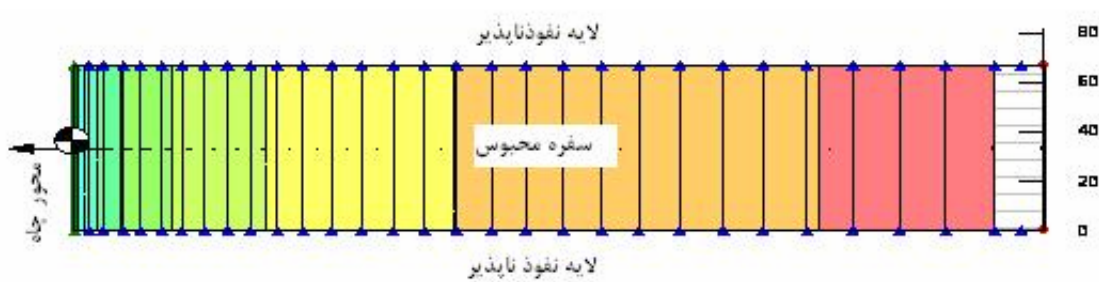
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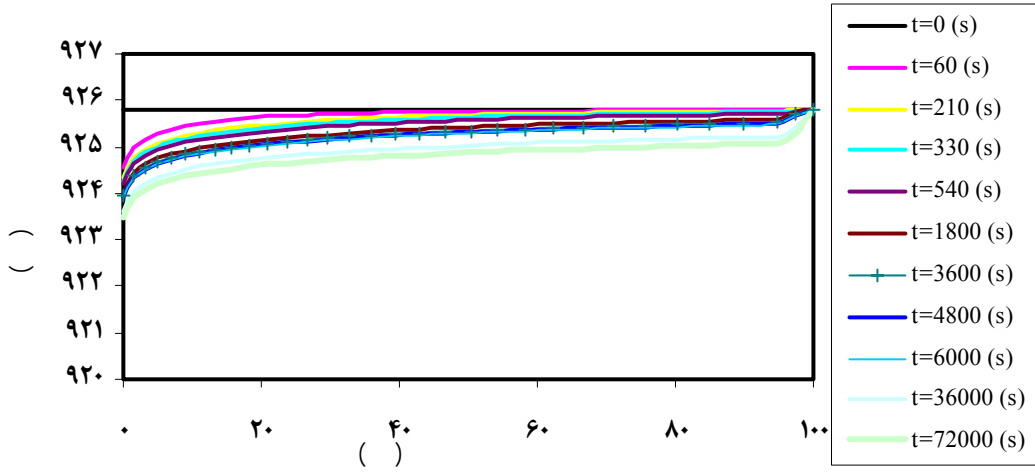
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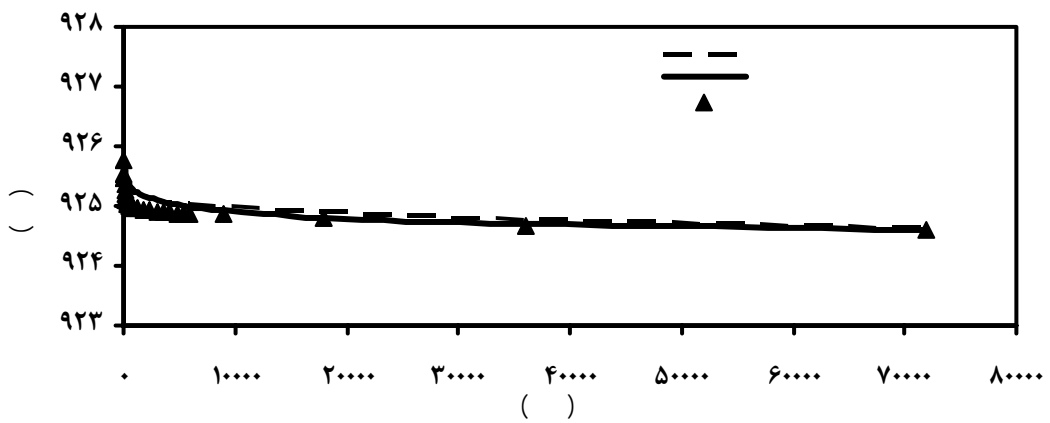


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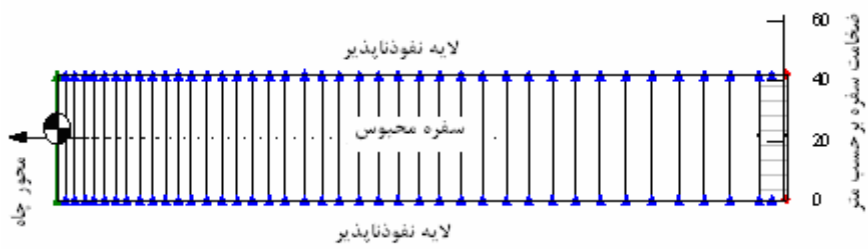
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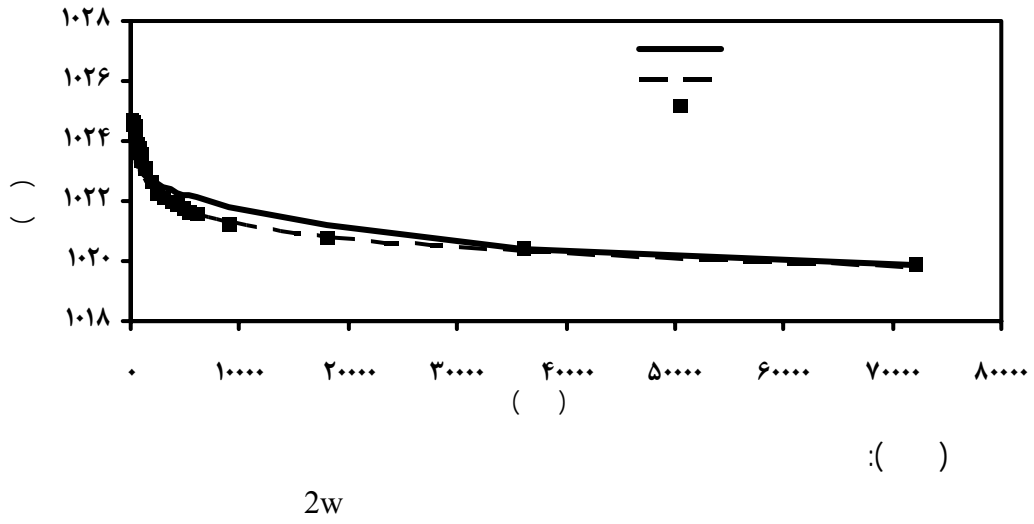
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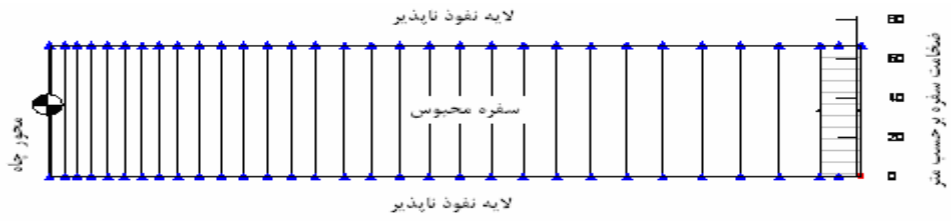
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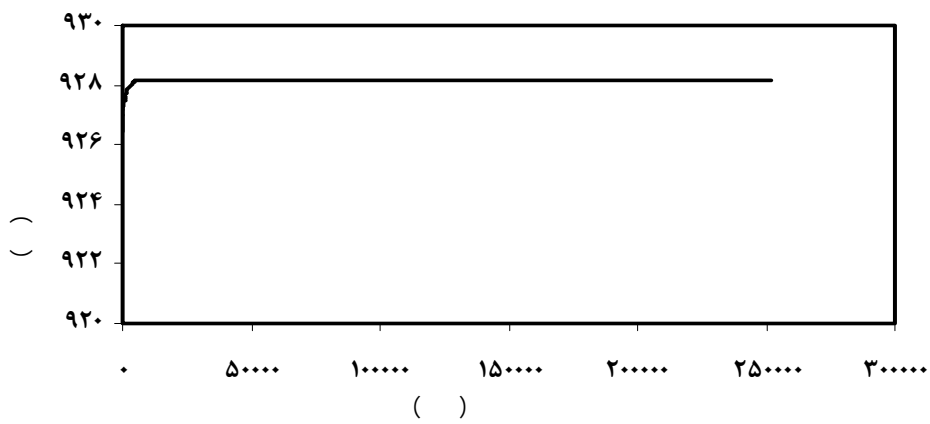
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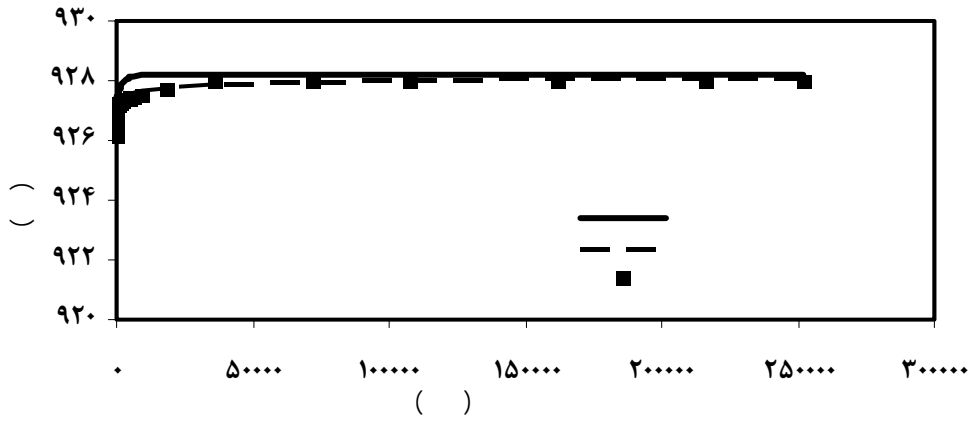


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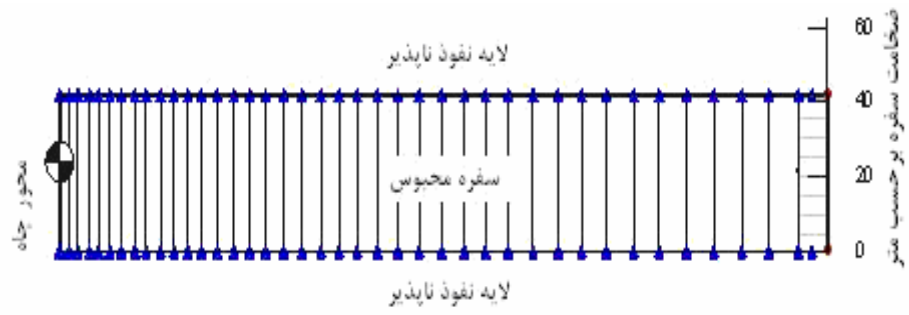
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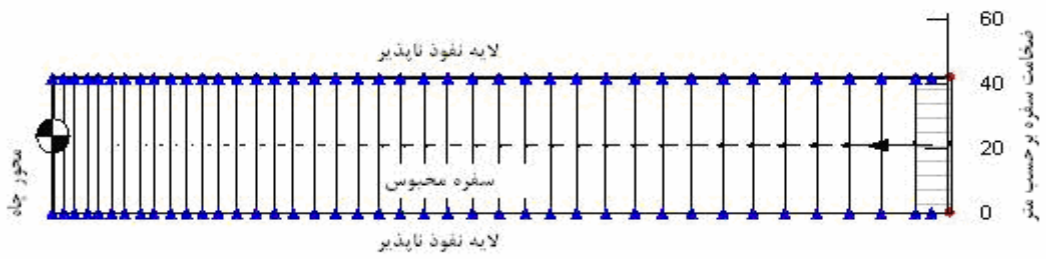
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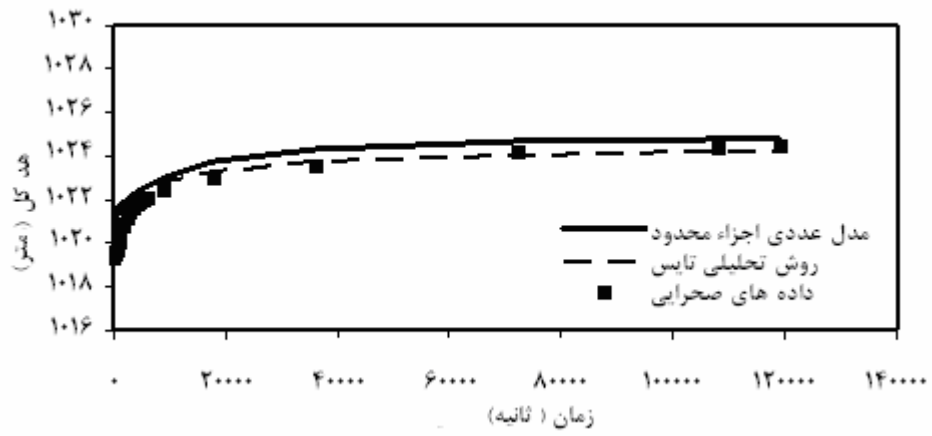
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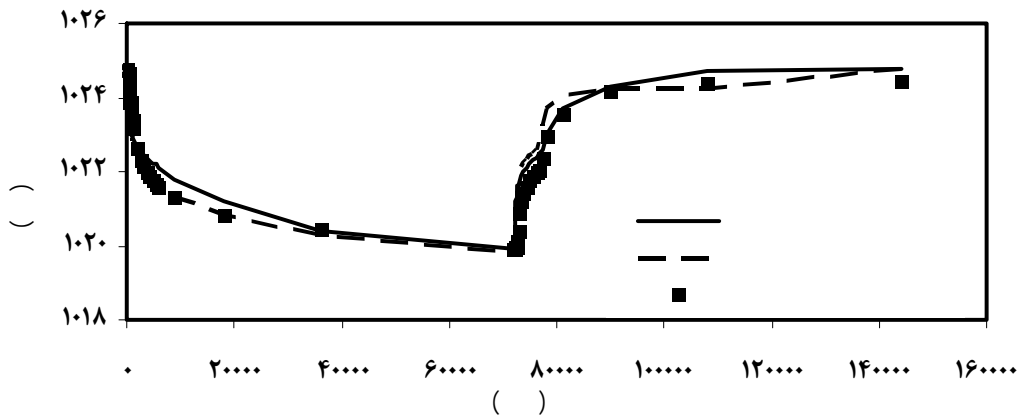
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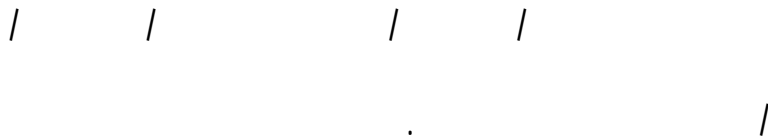
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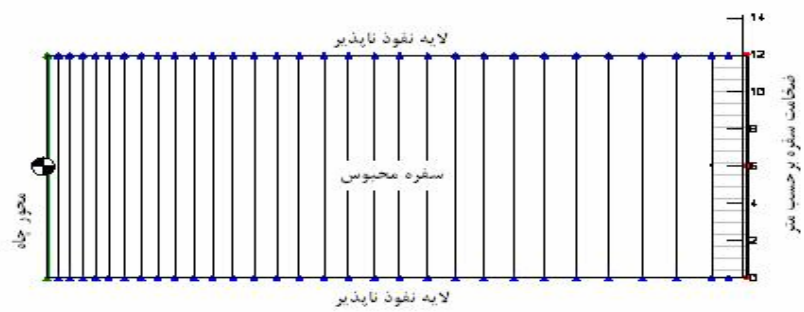


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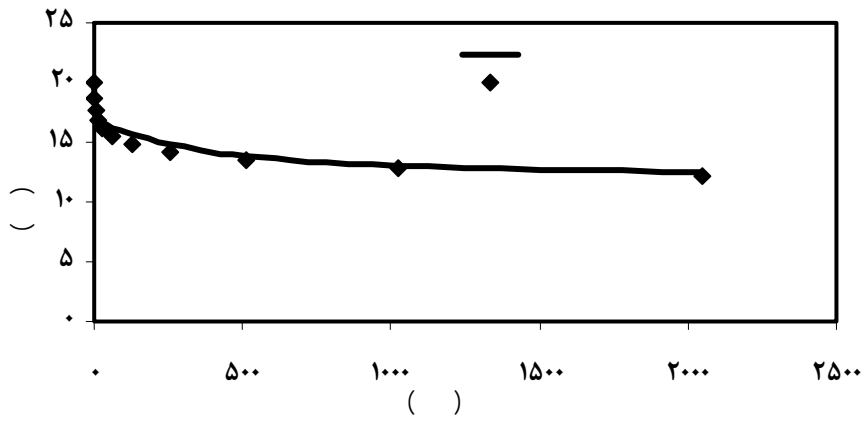
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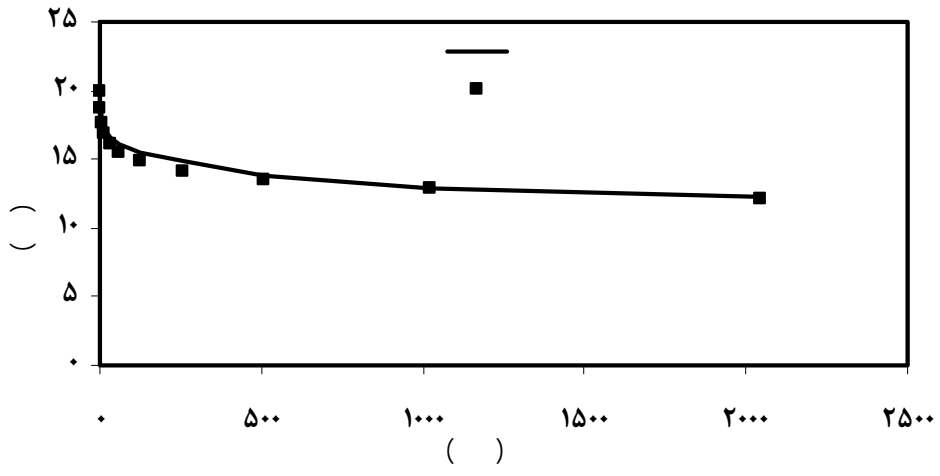


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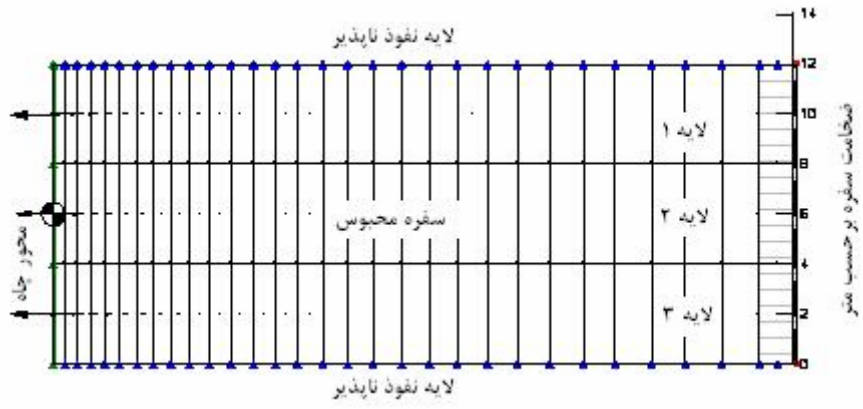
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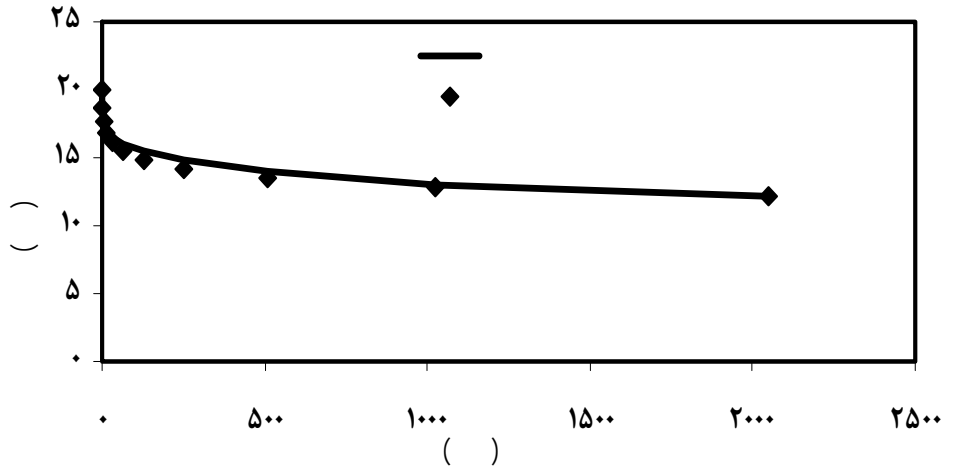
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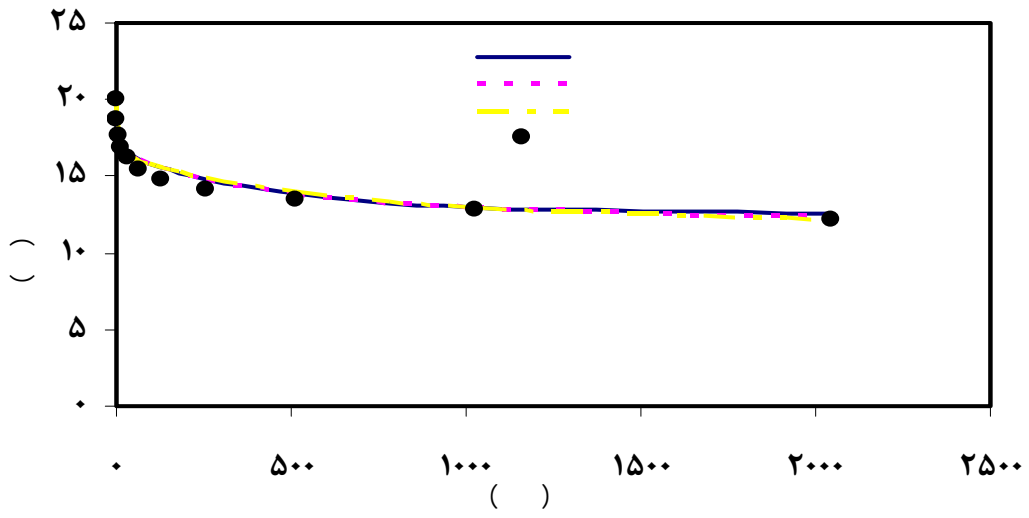
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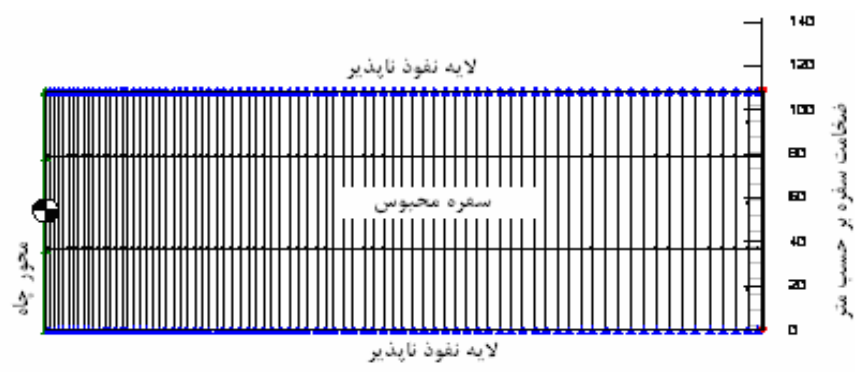
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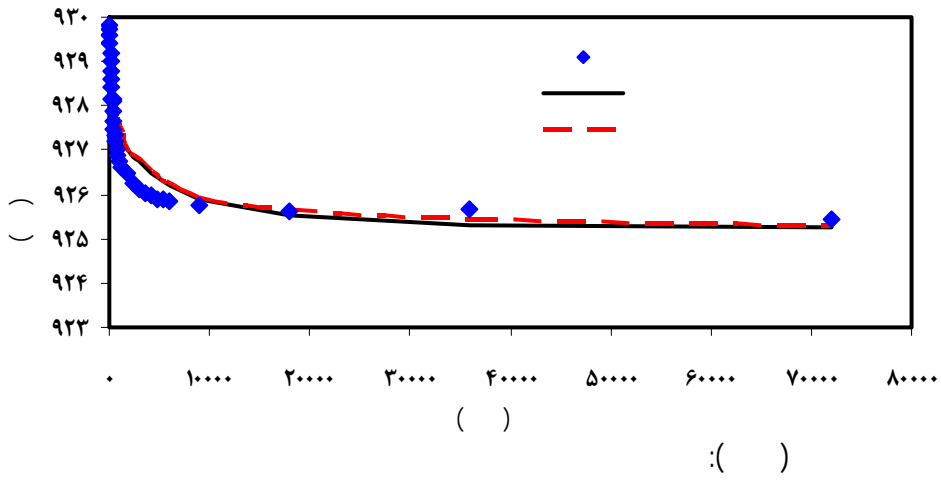


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(Singh and Atkins, 1985)

.(Azrag *et al.*, 1994)

.(Marinelli and Nicoli, 2000)

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.(Singh and Atkins, 1985)

$$Q=2\pi TDW(\lambda)$$

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(Singh and Atkins,

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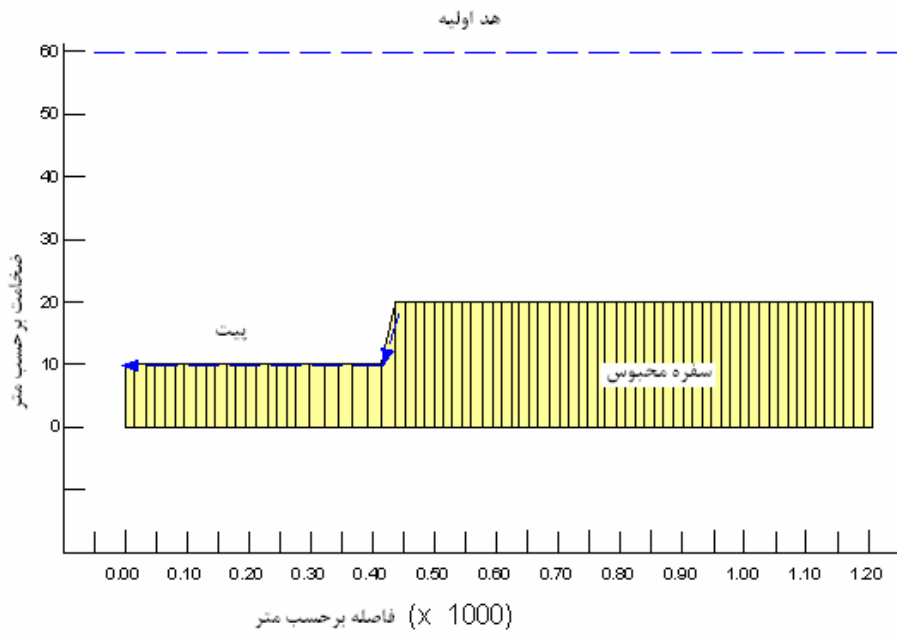
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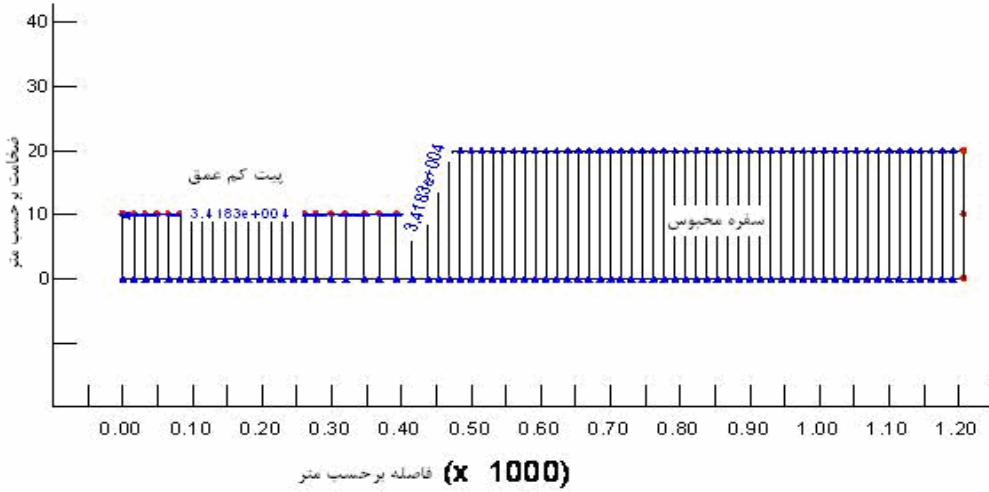


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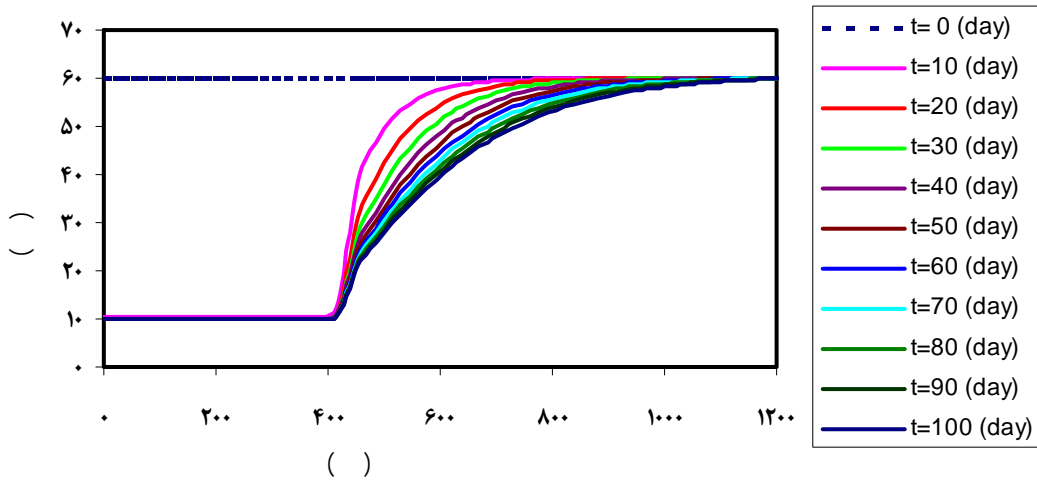
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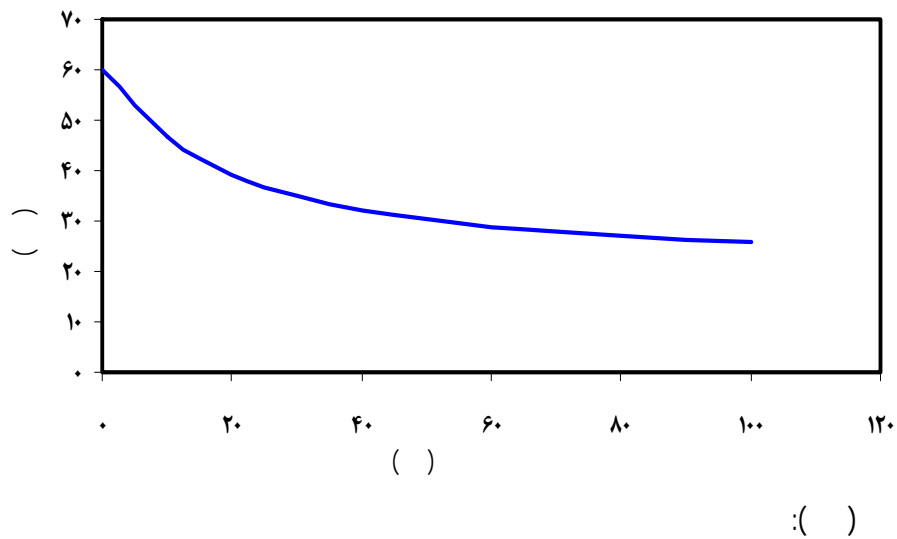


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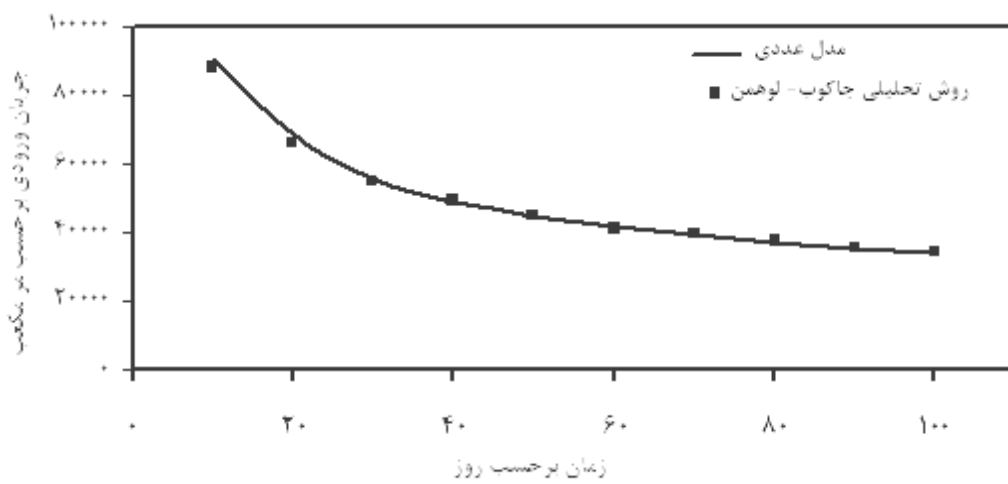


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$$Q = 2\pi T D W(\lambda)$$

$$\lambda = \frac{T t}{r^2 S}$$

$$W(\lambda) = 0.1716$$

$$Q = 2 \times 3.14 \times 700.416 \times 60 \times 0.1716 = 45288.11 \frac{m^3}{day}$$

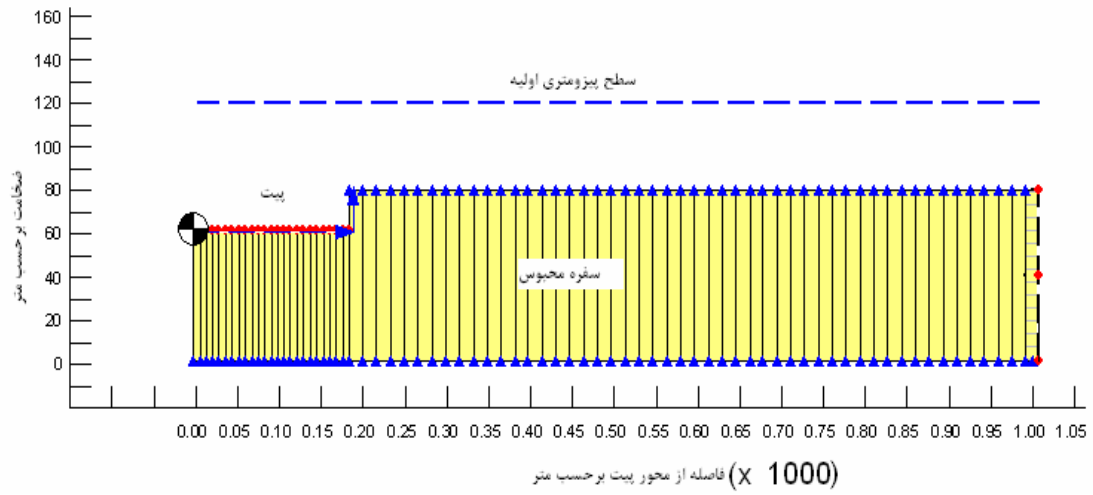
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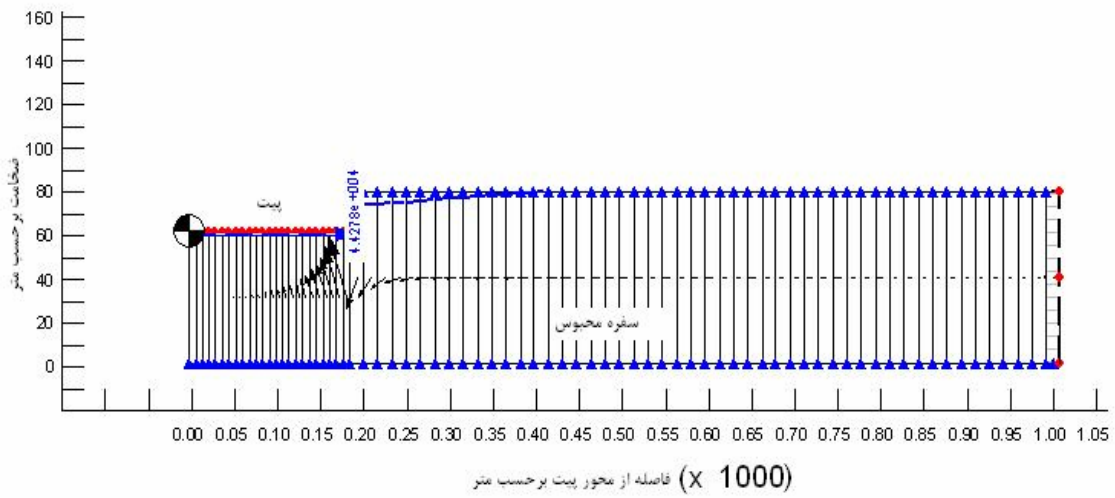
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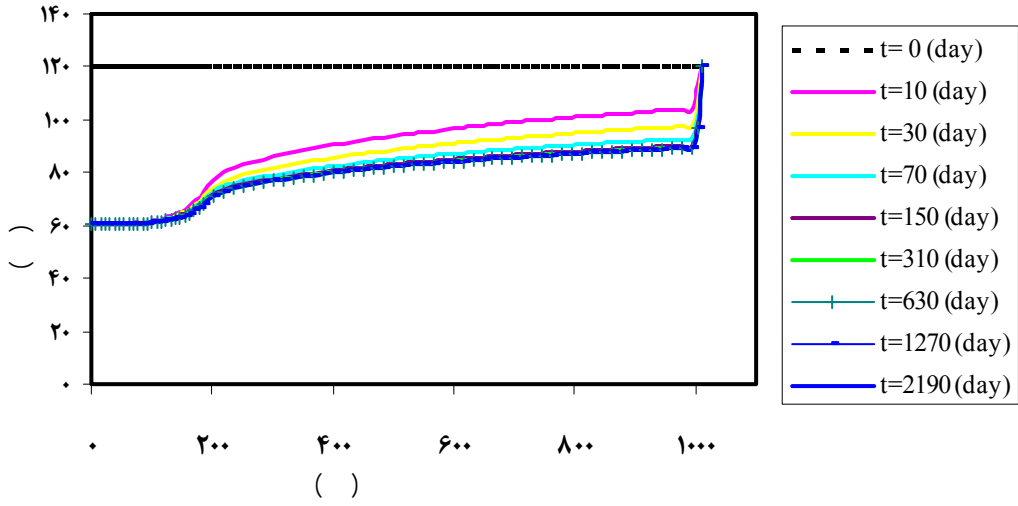
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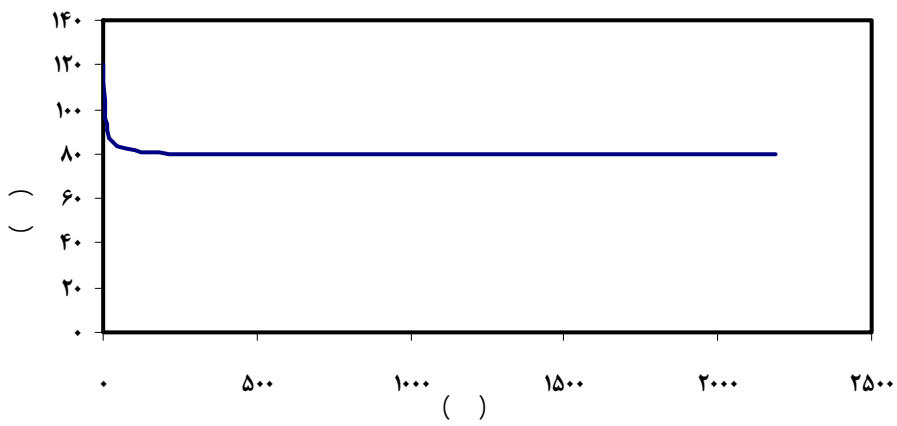
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$$W(\lambda) = 0.1839$$

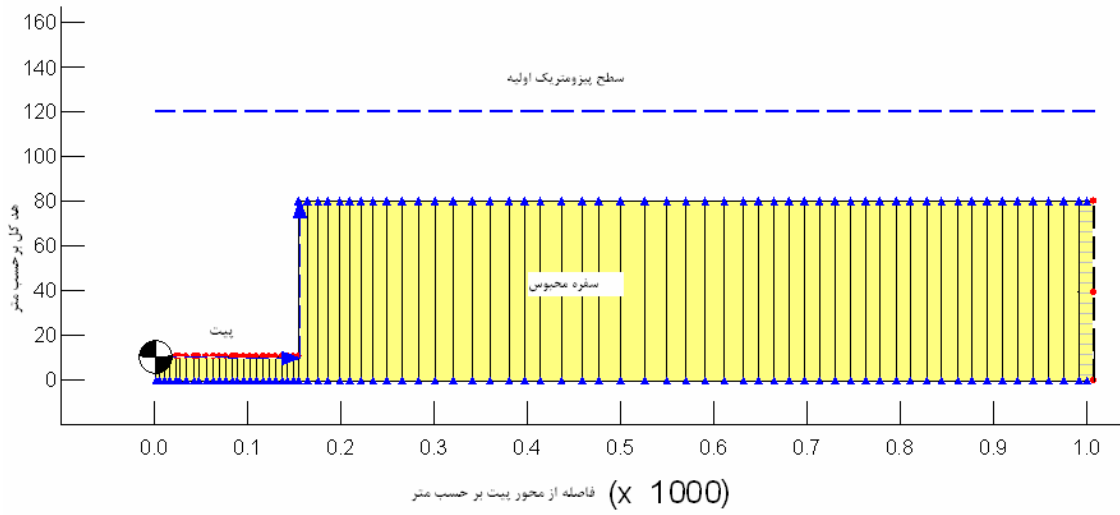
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$$Q = 2 \times 3.14 \times 700.416 \times 108 \times 0.18 = 85509 \frac{m^3}{day}$$

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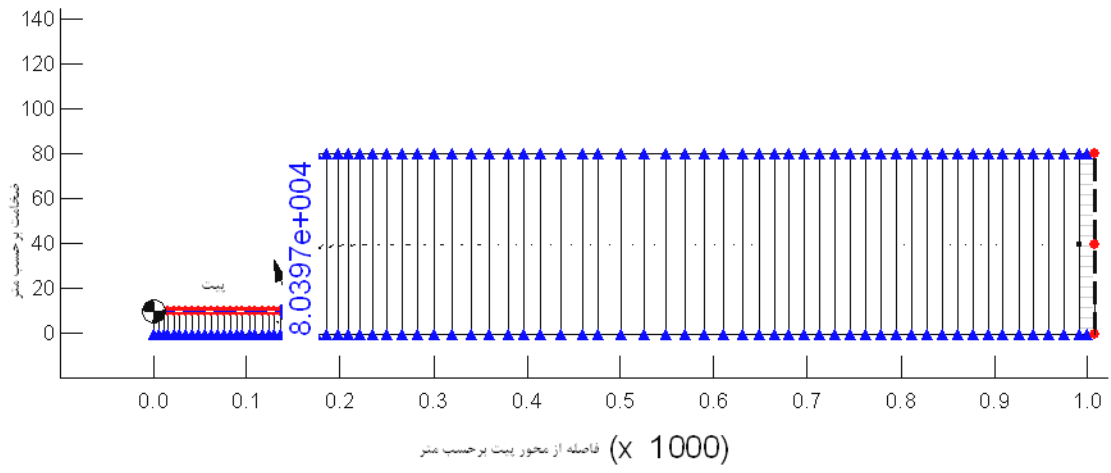
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- (Singh and Atkins, 1985a)

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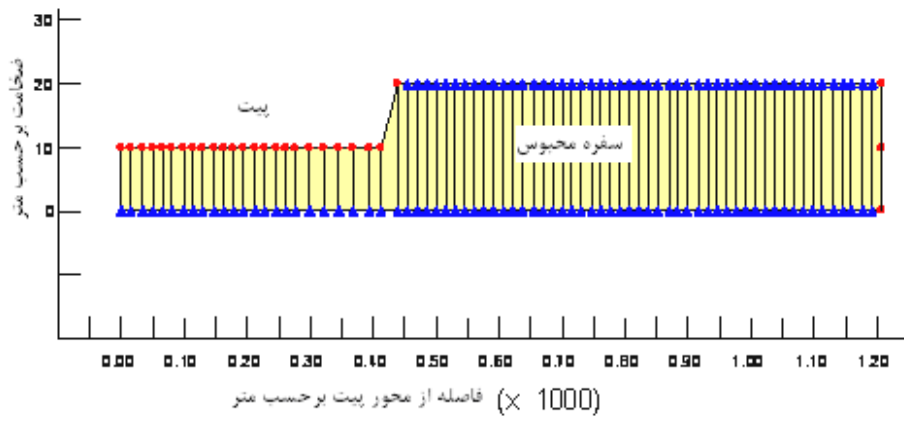
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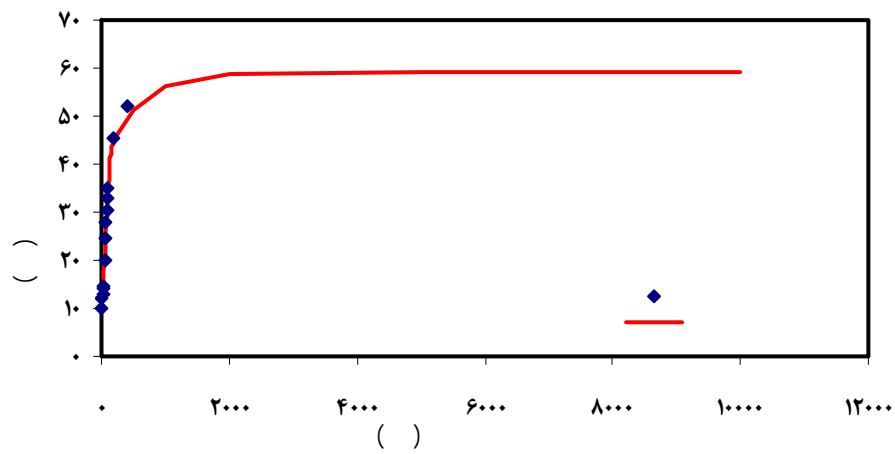
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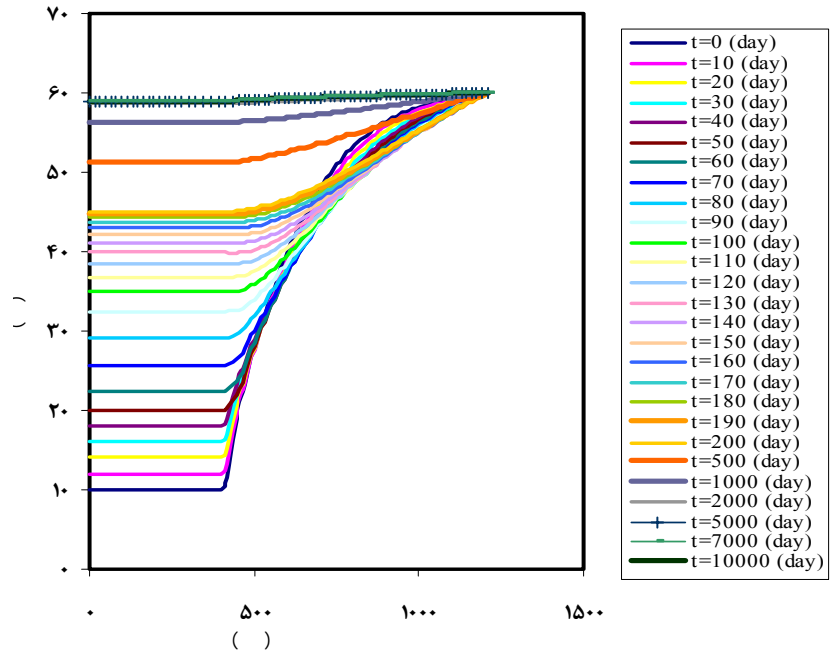
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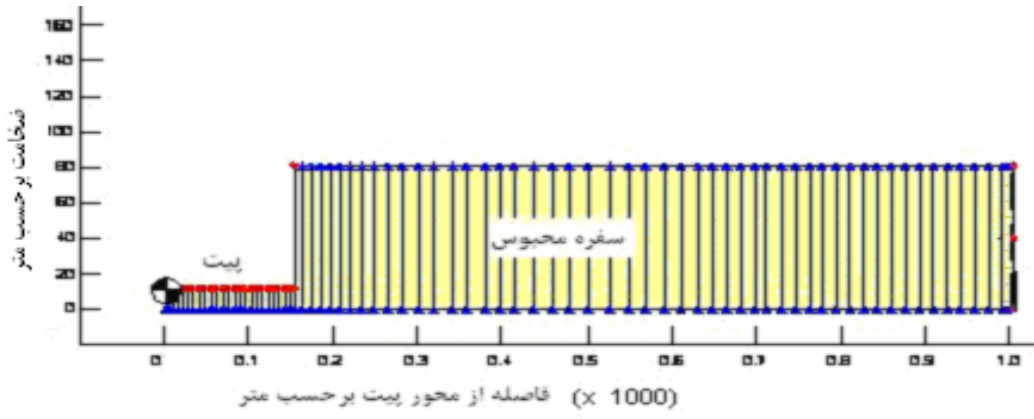
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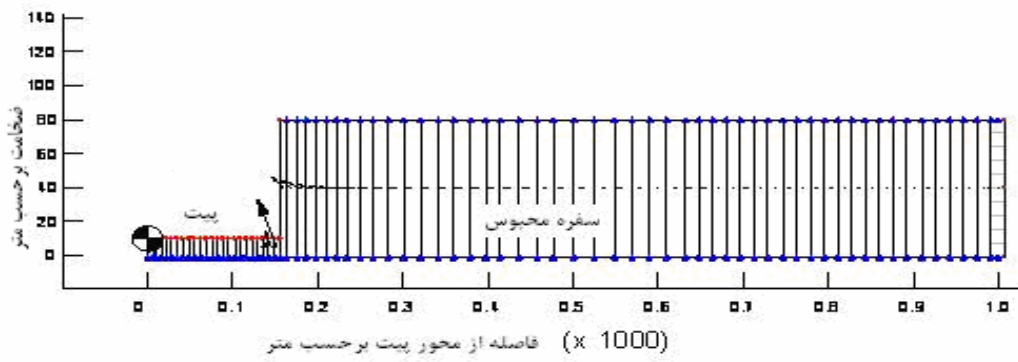
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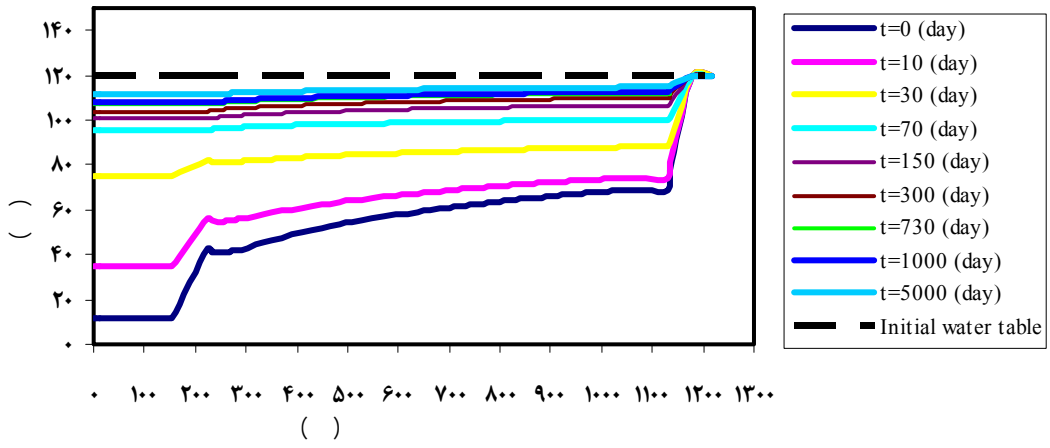
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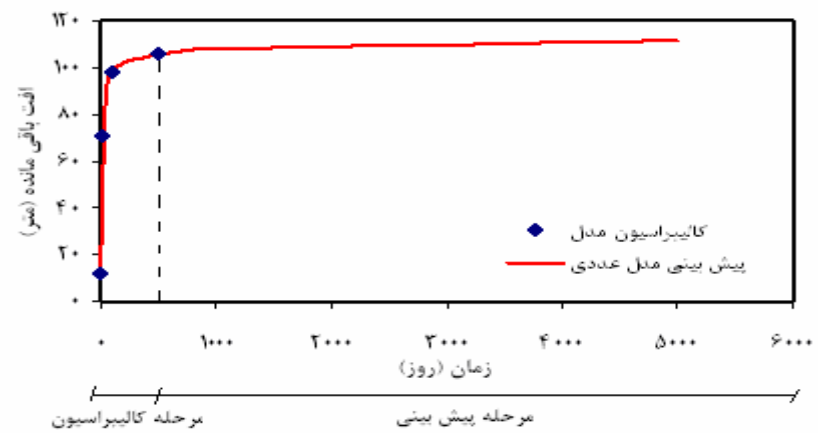
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Steger *et al.*, Jaynes *et al.*, 1983, 1984a,b Morth *et al.*, 1977 and Ritchie, 1986, 1987

Cathles and Cathles, 1979 Wounderly *et al.*, 1995 Scharer *et al.*, 1990 *al.*, 1990

(Hart *et al.*, 1991 Pantelis and Ritchie, 1991, 1992 Schlitt, 1980

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(Lefebvre *et al.*, 2001)

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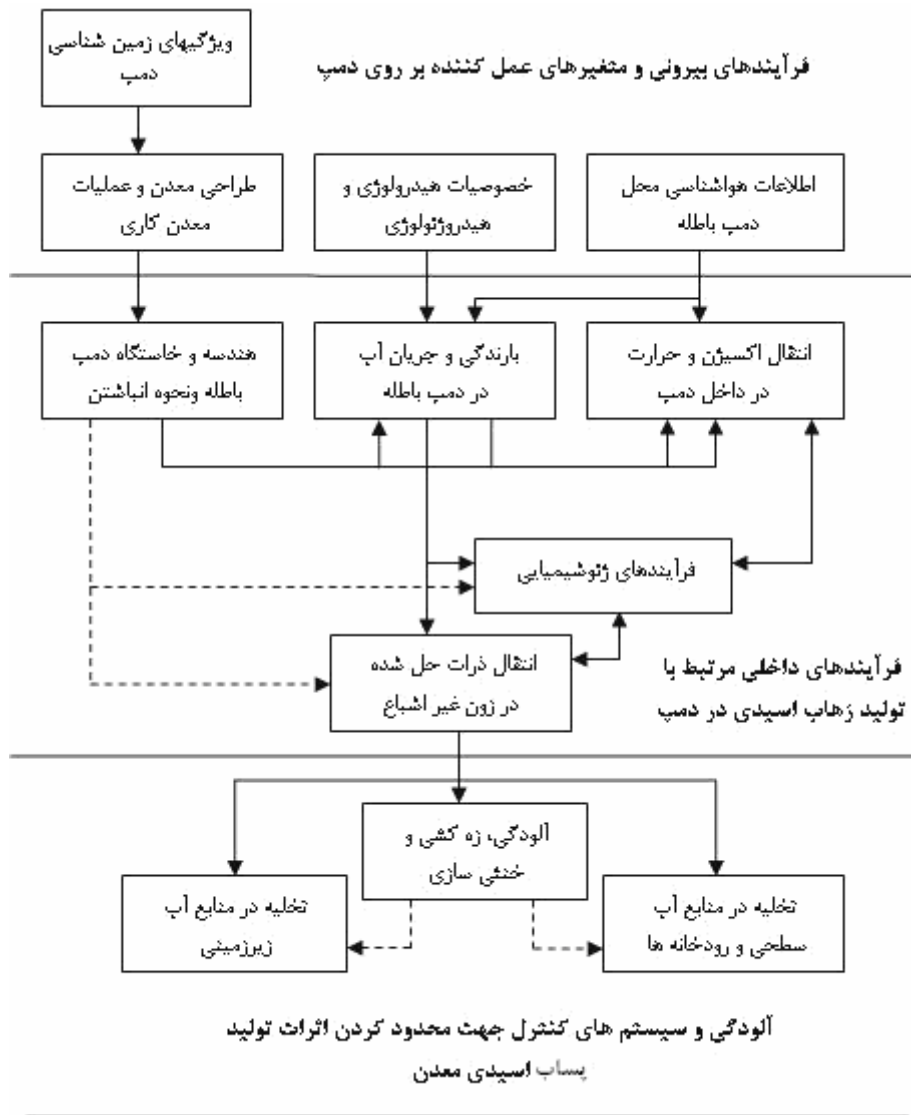
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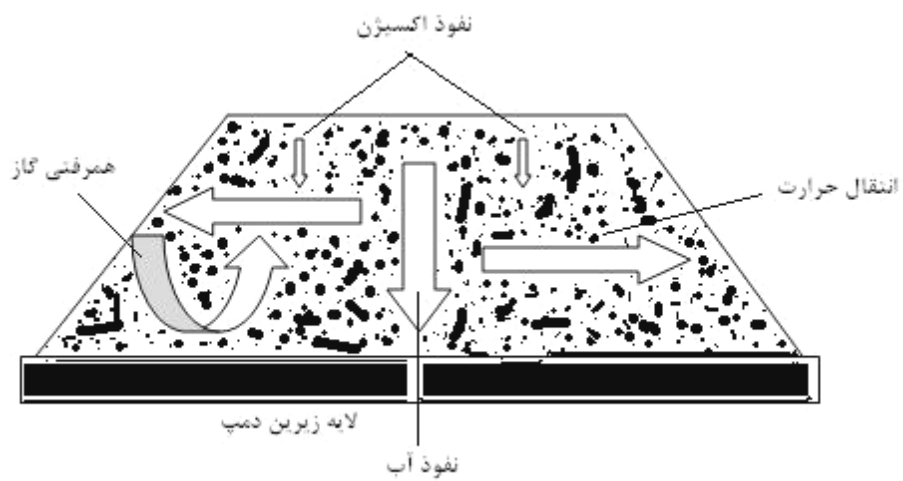


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(modified from Lefebvre et al., 2001)

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Doulati Ardejani *et al.*,)

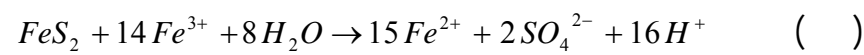
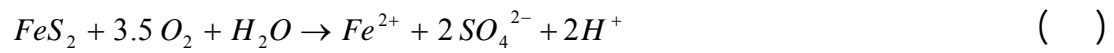
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- (Fes₂)

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.(Lefebvre *et al.*, 2001)

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$\frac{Fe^{3+}}{Fe^{2+}}$ / pH

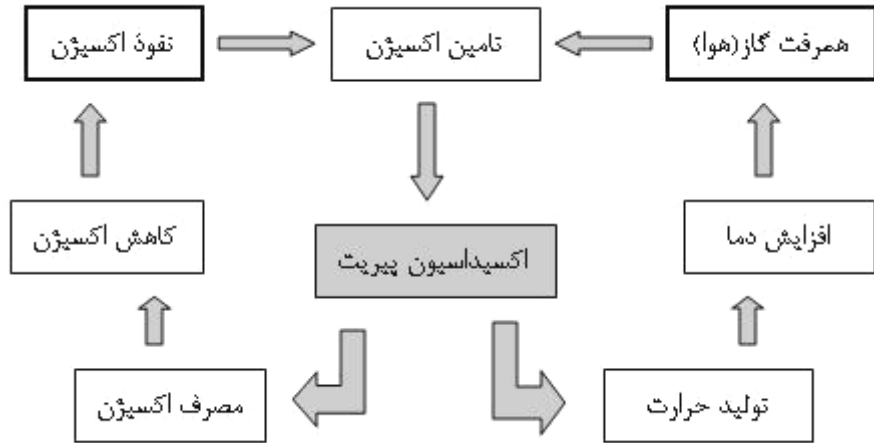
.(Doulati Ardejani *et al.*, 2003)

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(Cathles and Apps, 1975).

(Gelinas *et al.*, 1994).

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(Lefebvre *et al.*, 2001)

:(Magdalena, 2005)

$$F_{O_2}(t) = -\theta_a D_{eff} \frac{\partial C(t)}{\partial z} \quad ()$$

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t :C (t)

:Z

D_{eff}

.(Cathlese and Apps, 1975)

θ_t (S_r) θ_a

:(Elbering *et al.*, 1993) ()

$$\theta_a = \theta_t (1 - S_r) \quad ()$$

.(Yanful, 1993)

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$$\frac{\partial C}{\partial t} = D_e \frac{\partial^2 C}{\partial z^2}$$

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$$C(Z=0, t) = C_0 = 0.21$$

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$$C(\infty, t) = 0$$

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$$C(Z, 0) = 0$$

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$$C(z,t) = C_i + (C_0 - C_i) \operatorname{erfc}\left(\frac{z}{\sqrt{4D_z t}}\right) \quad ()$$

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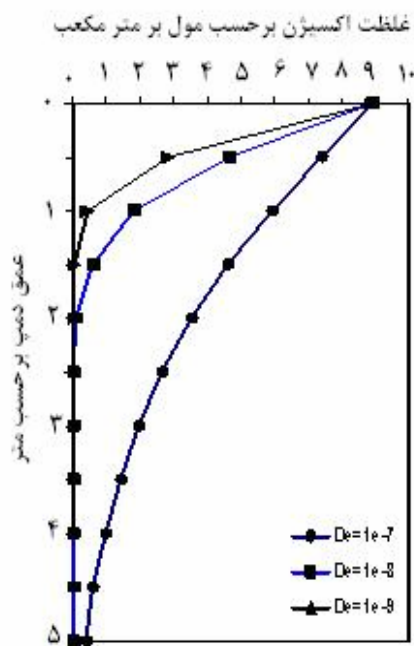
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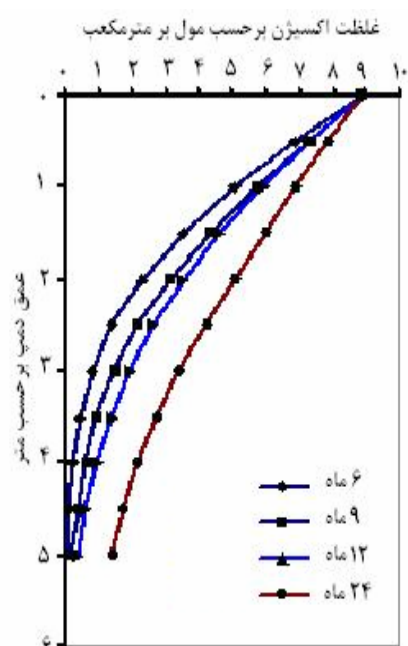
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(Lefebvre et al., 2001)

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	$1 \times 10^{-7} \text{ m}^2/\text{s}$

$$Y(\text{mg}) = X(\text{mg}) \times \left(\frac{1 \text{ mol. Fe}}{55.85 \text{ gr. Fe}}\right) \times \left(\frac{1 \text{ mol. FeS}_2}{1 \text{ mol. Fe}}\right) \times \left(\frac{119.85 \text{ gr. FeS}_2}{1 \text{ mol. FeS}_2}\right) \quad ()$$

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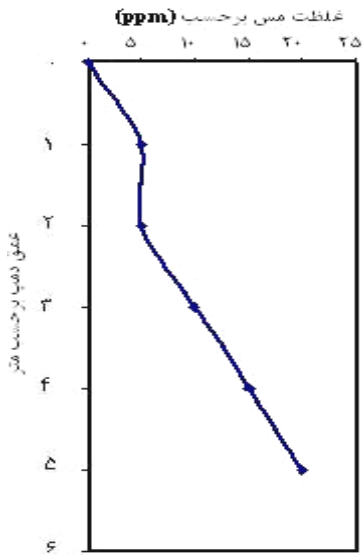
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K, Na, Mg, Ca

(Ni, Co, Fe, Cd, Cr, Zn, Cu)

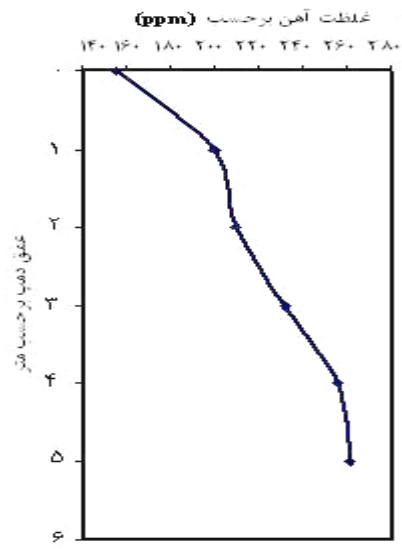
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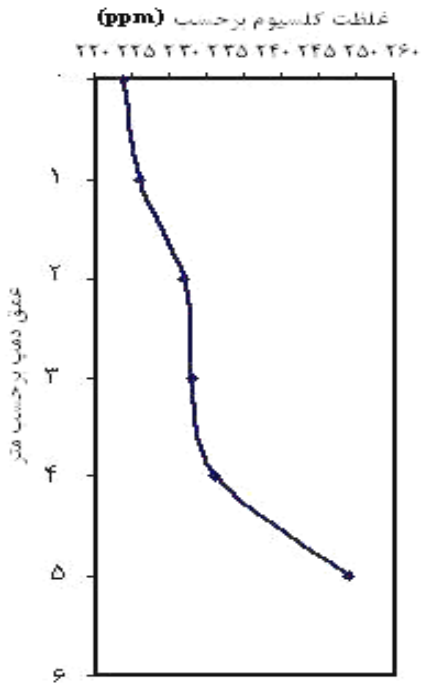
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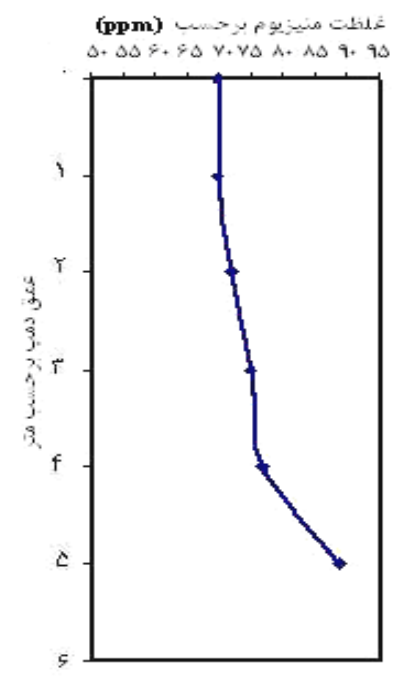


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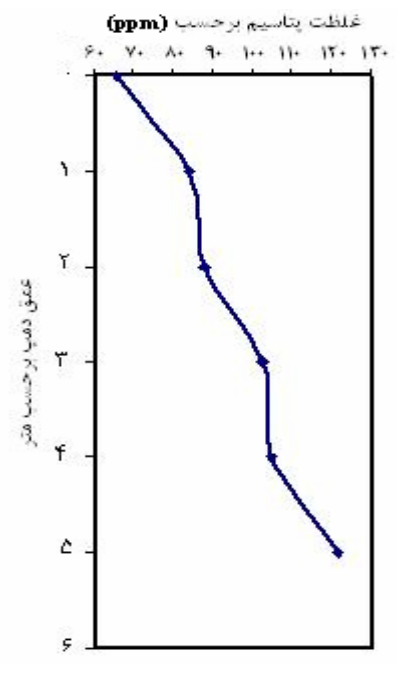
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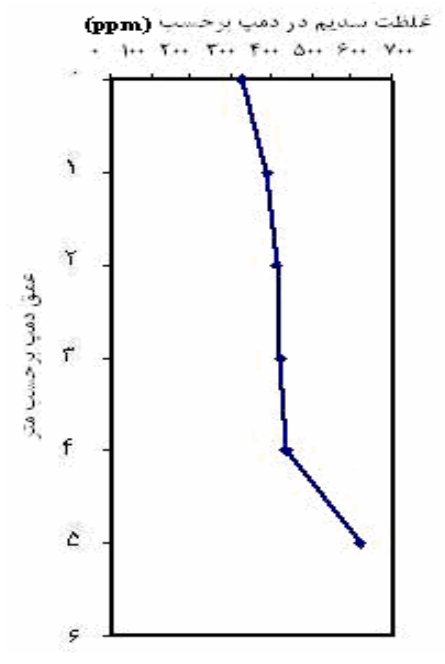
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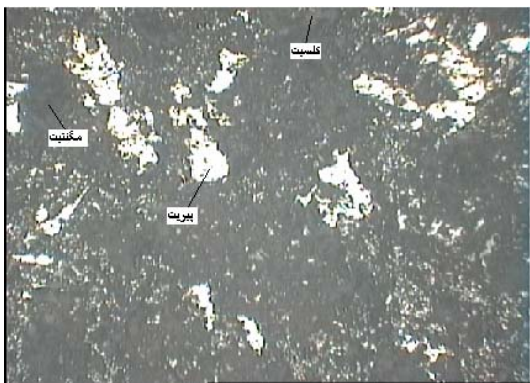
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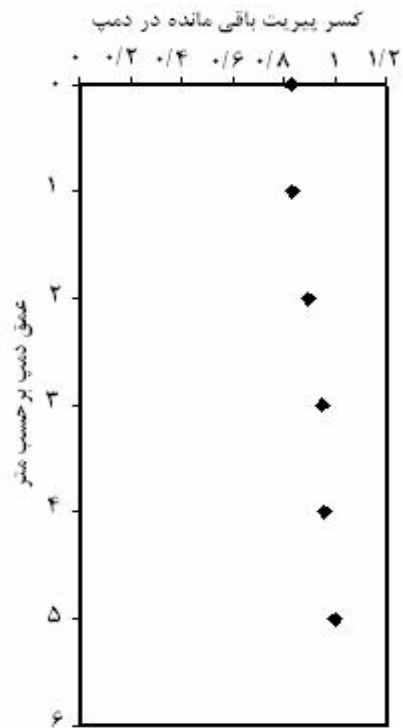
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.(Edwards *et al.*, 1995)

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‘Green and Clothier, 1994 ‘Putti *et al.*, 1990)

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Versteeg and Malalasekera,)

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PHOENICS

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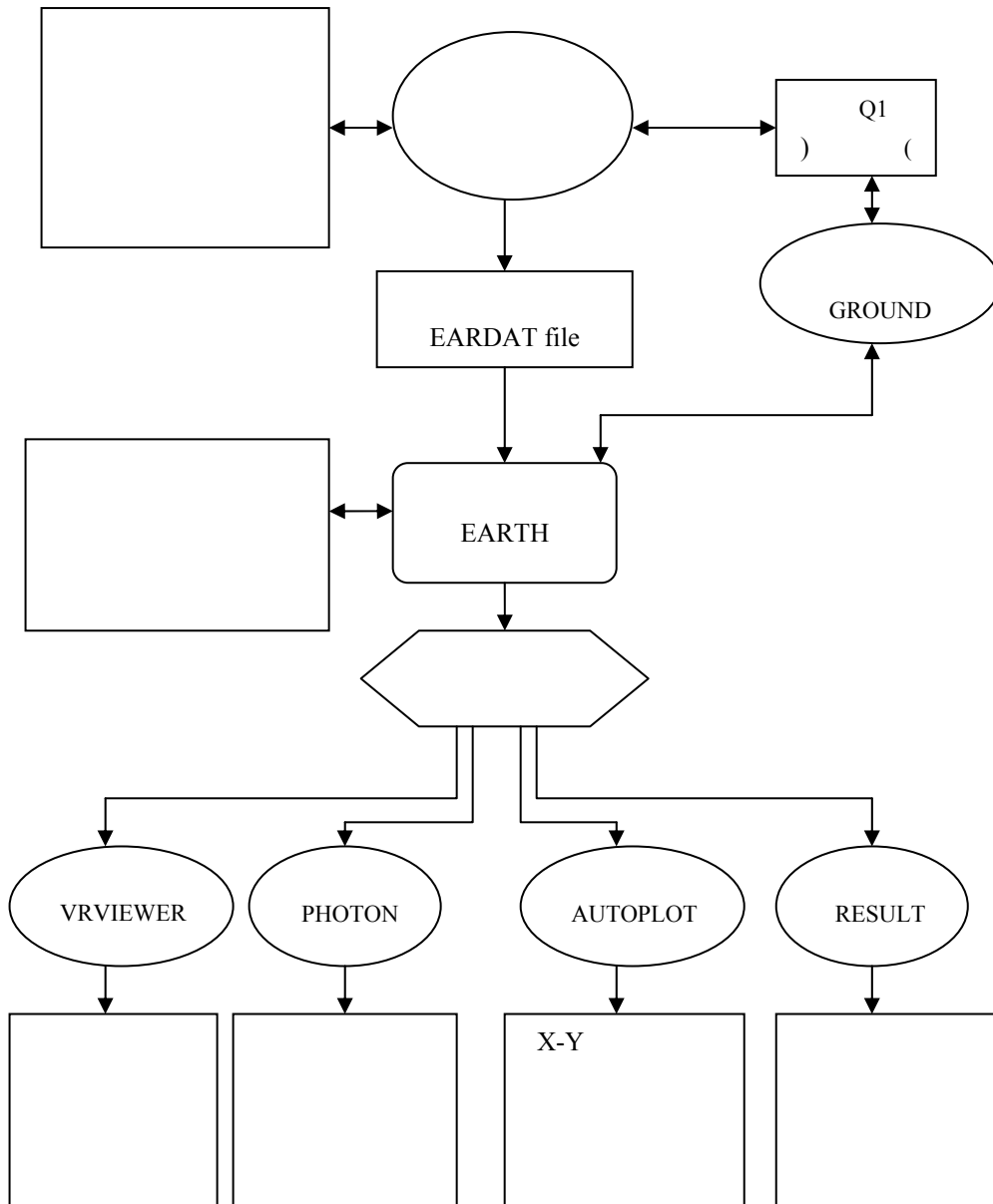
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() .(CHAM, 2007) RESULT AUTO PLOT VIEWER, PHOTON
 PHOENICS

(Edvard et al., 1995; Doulati Ardejani, 2003) CFD :()

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(Doulati Ardejani,, 2003) PHOENICS

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:(CHAM, 2007) PHOENICS

$$\frac{\partial}{\partial t}(r_i \rho_i \phi_i) + \frac{\partial}{\partial x_j}(r_i \rho_i u_{ji} \phi_i - r_i \Gamma_{\phi_i} \frac{\partial \phi_i}{\partial x_j}) = r_i S_{\phi_i} \quad ()$$

$$r_i S_{\phi_i} - r_i \Gamma_{\phi_i} \frac{\partial \phi_i}{\partial x_j} + r_i \rho_i u_{ji} \phi_i + \frac{\partial}{\partial t}(r_i \rho_i \phi_i) \quad ()$$

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: ρ_i

x_j

: u_{ji}

i

ϕ

: Γ_{ϕ_i}

ϕ_i

: S_{ϕ_i}

()

r_i

:

$$\frac{\partial}{\partial t}(\rho \phi) + \frac{\partial}{\partial x_j}(\rho u_j \phi - \Gamma_{\phi} \frac{\partial \phi}{\partial x_j}) = S_{\phi} \quad ()$$

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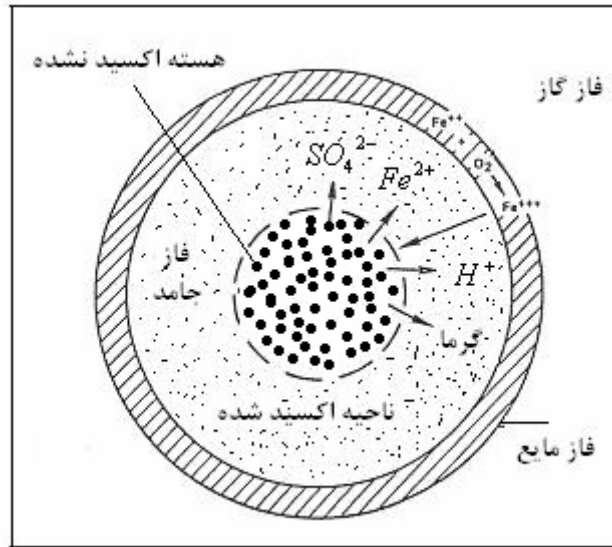
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(Cathlese and Apps, 1975)

$$\frac{dX}{dt} = \frac{-3X^{\frac{2}{3}}}{6\tau_{D[Ox]} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}}\right) + \tau_{C[Ox]}} \quad)$$

() :

$$\frac{\partial X}{\partial t} = \frac{-3X^{\frac{2}{3}}}{6\tau_{D_{[O_2]}} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}}\right) + \tau_{C_{[O_2]}}} + \frac{-3X^{\frac{2}{3}}}{6\tau_{D_{[Fe^{3+}]}} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}}\right) + \tau_{C_{[Fe^{3+}]}}} \quad ()$$

:

() :X

:t

: τ_D

: τ_C

:Oxd

:(Jaynes *et al.*, 1984a)

τ_C τ_D

$$\tau_D = \frac{\rho_{Py} R^2}{6bD_{e[Ox]} C_{[Ox]}} \quad ()$$

$$\tau_C = \frac{\rho_{Py} R}{bK_{[Ox]} \alpha_{Py}^{rock} \lambda C_{[Ox]}} \quad ()$$

:

: ρ_{Py}

:R

:B

: $D_{e[Ox]}$

: $K_{[Ox]}$

: α_{Py}^{rock}

: λ

: $C_{[Ox]}$

:(Doulati Ardejani *et al.*, 2003)

$$\alpha_{Py}^{rock} = 1000 \times \rho_{Prctl} \left(\frac{G_{Py} \rho_{Prctl}}{D_{Py}} \right)^{\frac{2}{3}} \quad ()$$

:

: ρ_{Prctl}

: D_{Py}

() : G_{Py}

/

()

:(Cathlese and Apps, 1975)

$$\delta = \sqrt{\frac{D'_{OX} \phi_R^L}{k_{OX} T_R^L a_{sulf}^R}} \quad ()$$

: δ

: D'_{OX}

⁴³ Reaction skin depth

$:\phi_R^L$

$:k_{OX}$

$:T_R^L$

$:a_{Sulf}^R$

Doulati (Lefebvre *et al.*, 2001)

AMD

(Ardejani *et al.*, 2004

(Doulati Ardejani *et al.*, 2004 (Magdalena, 2005 (Jaynes *et al.*, 1984)

(D_e)

(φ_a)

Jaynes)

:(et al., 1984

$$\phi_a \frac{\partial u}{\partial t} = D_e \left(\frac{\partial^2 u}{\partial x_j^2} \right) + S_{K_{Py-O_2}} + S_{K_{Fe^{2+}-O_2}} \quad (\quad)$$

:

$:\phi_a$

$:u$

$:D_e$

$:x_j$

$S_{K_{Fe^{2+}-O_2}}$

$S_{K_{Py-O_2}}$

$$C_{[O_2]} = \gamma u \quad ()$$

:

$$: C_{[O_2]}$$

: u

/

: \gamma

$$()$$

$$()$$

$$S_{K_{Py-O_2}}$$

$$()$$

:

$$S_{K_{Py-O_2}} = \frac{-3(1-\phi) b^{-1} \rho_s X^{\frac{2}{3}}}{6\tau_{D_{O_2}} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}}\right) + \tau_{C_{O_2}}} \quad ()$$

\phi

pH

pH

: (a)

$$S_{K_{Fe^{2+}} - O_2} = -\phi_w b'^{-1} [Fe^{2+}] u \left\{ K_1 \left(\frac{1}{[H^+]} \right)^2 + K_2 \right\} \quad ()$$

:

b' :

/ pH : K_1

/ pH : K_2

: ϕ_w

:(modified from Jaynes *et al.*, 1984; Doulati Ardejani *et al.*, 2004)

$$\phi_a \frac{\partial u}{\partial t} = D_e \left(\frac{\partial^2 u}{\partial x_j^2} \right) - \frac{3(1-\phi)b^{-1}\rho_s X^{\frac{2}{3}}}{6\tau_{D_{O_2}} X^{\frac{1}{3}}(1-X^{\frac{1}{3}}) + \tau_{C_{O_2}}} - \phi_w b'^{-1} [Fe^{2+}] u \left\{ K_1 \left(\frac{1}{[H^+]} \right)^2 + K_2 \right\} \quad ()$$

$$1.7 \times 10^{-9} \text{ s}^{-1} \quad 1.3 \times 10^{-10} \text{ s}^{-1}$$

$$K_2 \quad K_1$$

:

:

$$u(0,t) = u_0 = 9 \text{ mol m}^{-3} \quad ()$$

:

$$\frac{\partial u}{\partial x_j}(L,t) = 0 \quad ()$$

:

:L

:

$$u(x_j, 0) = 0 \quad ()$$

modified from Cathlese and Apps, 1975; Doulati Ardejani,)

:(2003

$$\rho_b C_p \frac{\partial T}{\partial t} = K_T \left(\frac{\partial^2 T}{\partial x_j^2} \right) - \rho_w C_w u_{x,w} \frac{\partial T}{\partial x_j} + \frac{3(1-\phi)B^{-1} \rho_s X^{\frac{2}{3}}}{6 \tau_{D_{O_2}} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}} \right) + \tau_{C_{O_2}}} + \frac{3(1-\phi)B'^{-1} \rho_s X^{\frac{2}{3}}}{6 \tau_{D_{Fe^{3+}}} X^{\frac{1}{3}} \left(1 - X^{\frac{1}{3}} \right) + \tau_{C_{Fe^{3+}}}} \quad ()$$

:

:T

: ρ_b

:K

:t

: ρ_w

: $u_{x_j, w}$

: C_w

:B

:B'

(Doulati Ardejani, 2003)

:

/ :

6.9×10^{-7} :B

/ :

5.6×10^{-5} :B'

:

$$T(x_j, 0) = 18 \text{ }^\circ\text{C}$$

()

()

:(Freeze and Cherry, 1979)

$$\phi \frac{\partial C_i}{\partial t} = D_{x_j} \frac{\partial^2 C_i}{\partial x_j^2} - q_j \frac{\partial C_i}{\partial x_j} \pm S \quad i = 1, 2, \dots, n \quad ()$$

:

: C_i

: ϕ

: q_j

: D_{x_j}

: S

: x_j

: t

PHOENICS

- (Doulati Ardejani et al., 2004)

GROUND q_1

C

GROUND

q₁

PHEONICS

C

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	2.7×10^{-2}	
	1×10^{-7}	
	/	()

C

/

() Z

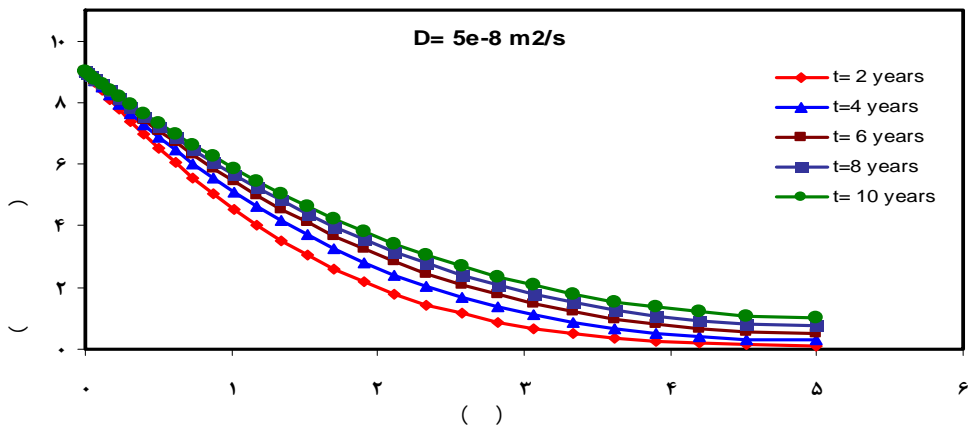


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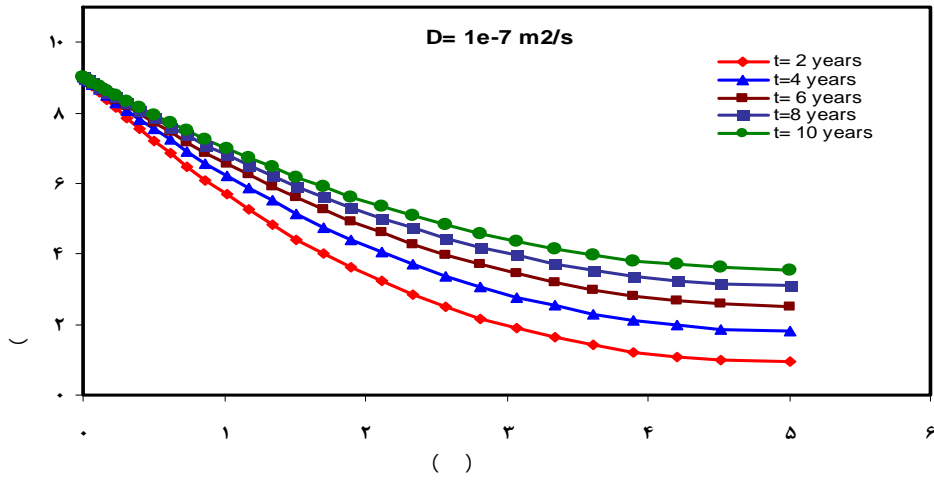
1×10^{-6} 1×10^{-7} 5×10^{-8}

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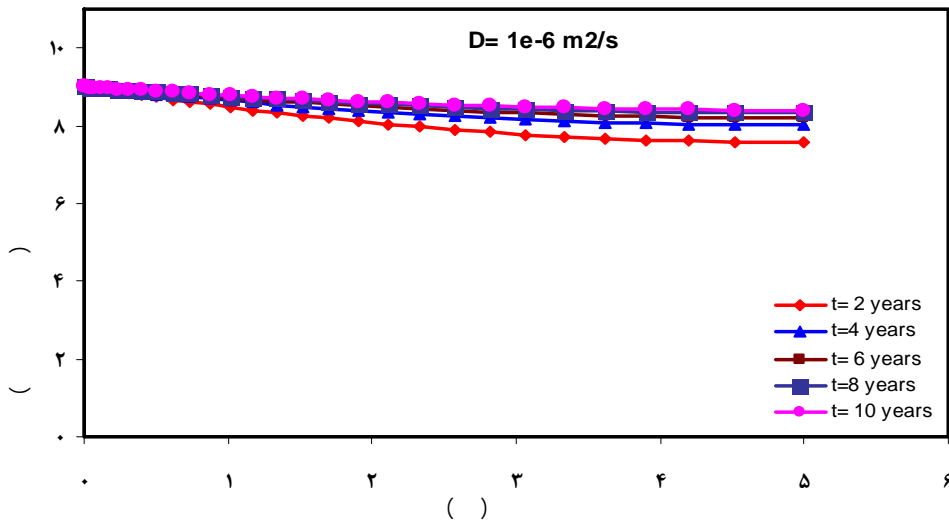


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1×10^{-6} : ()

() ()

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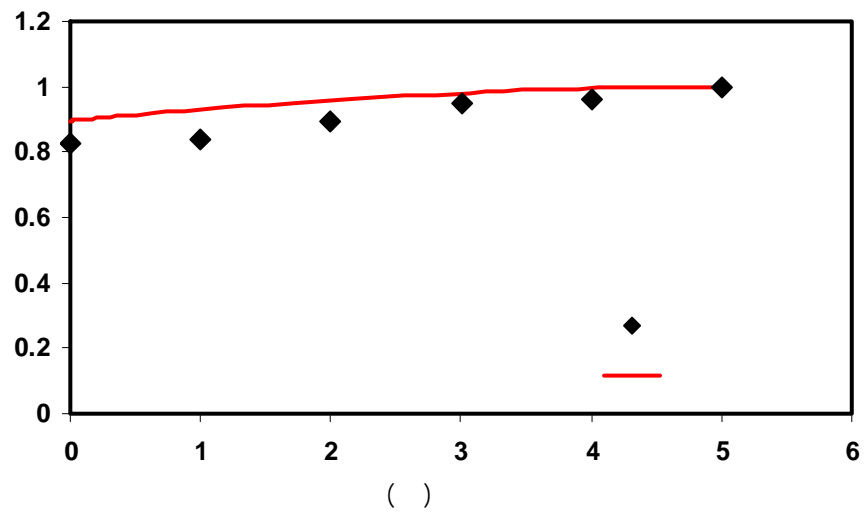
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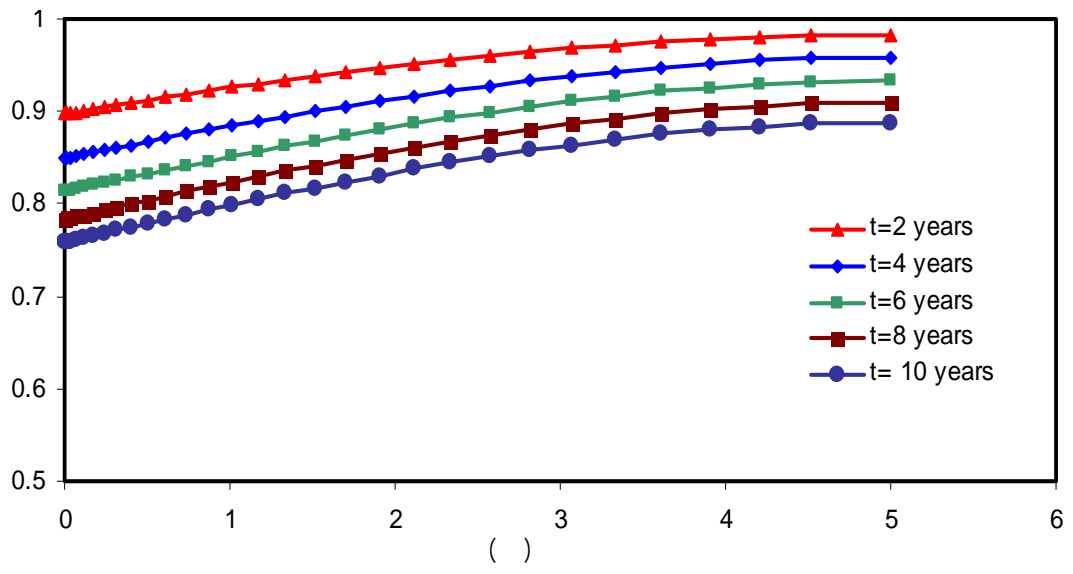
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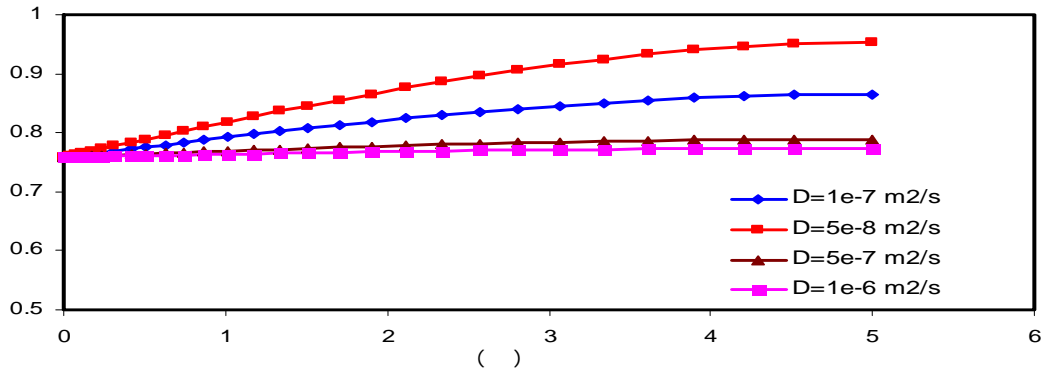
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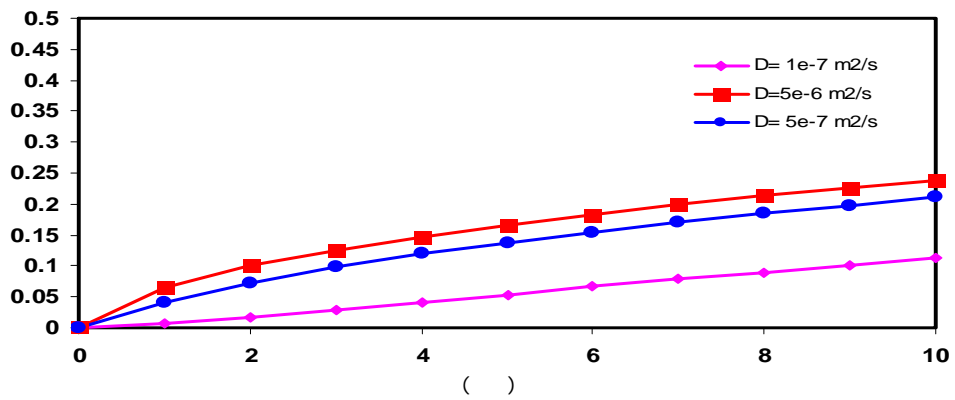
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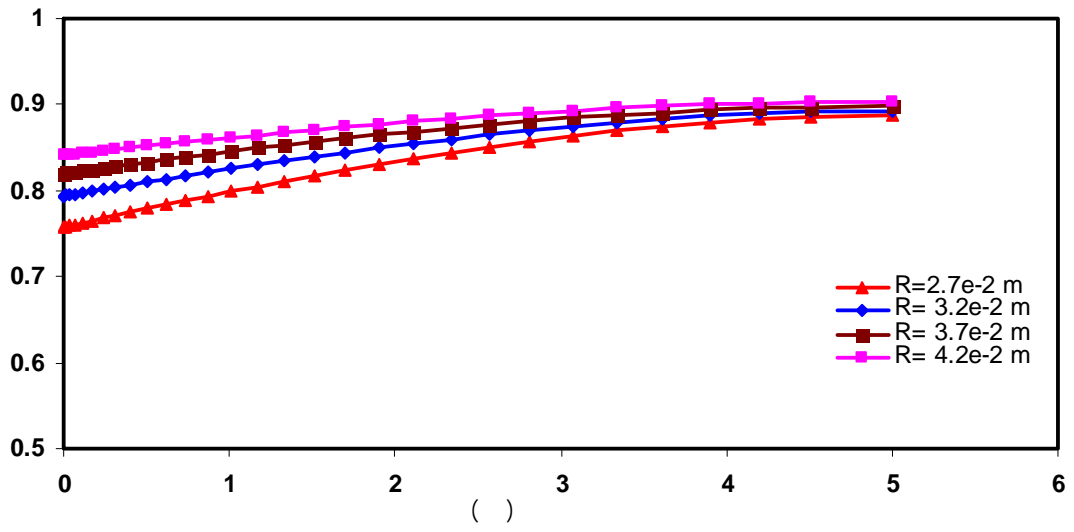
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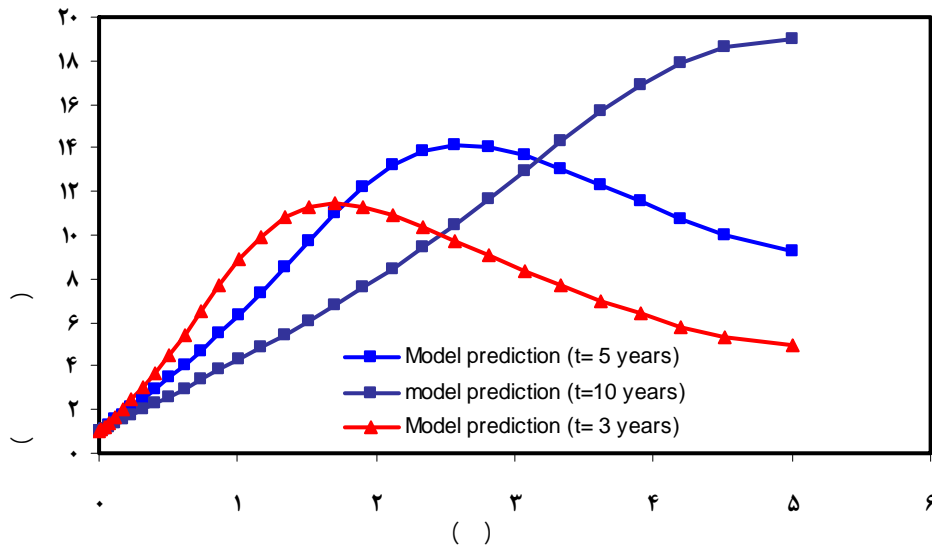
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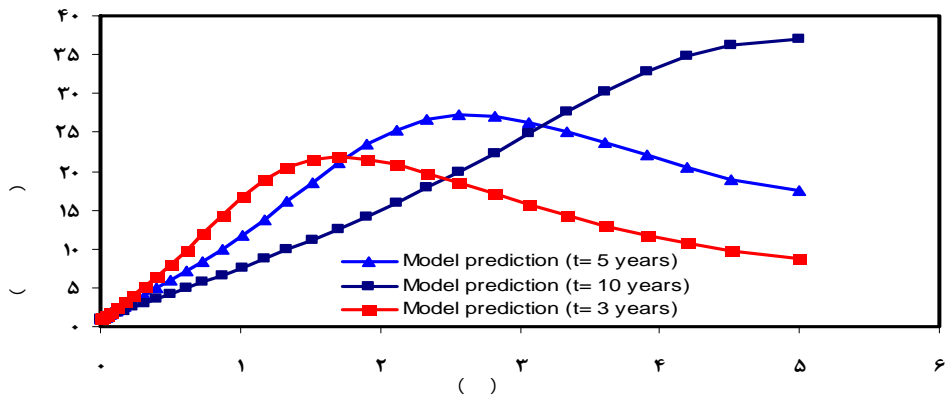
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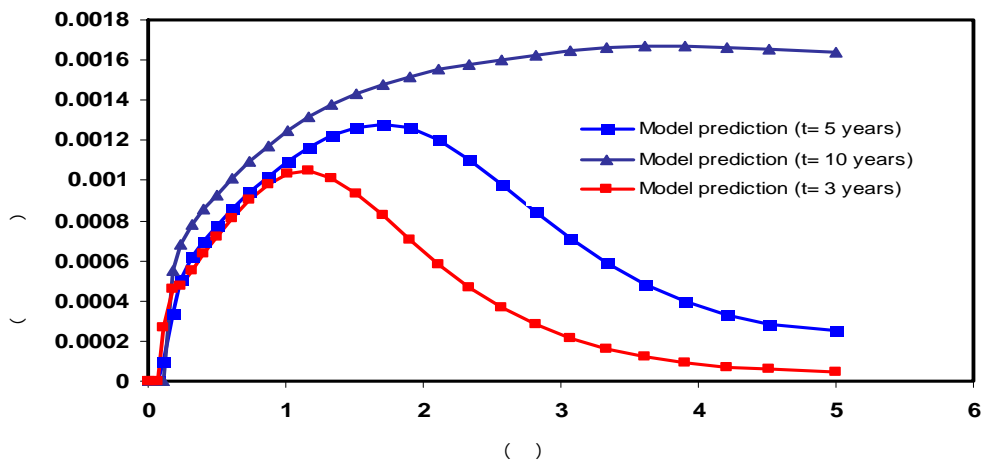
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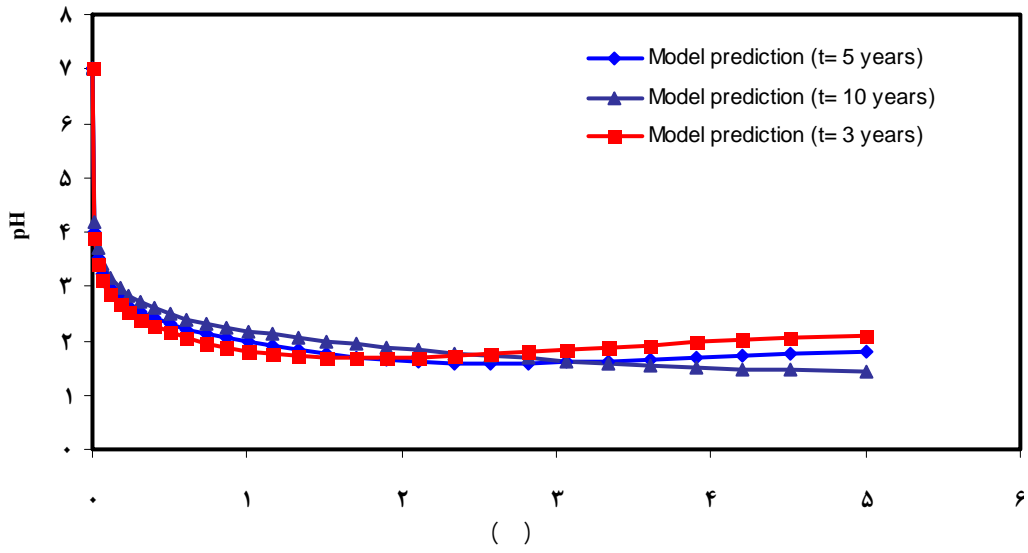
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pH : ()

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pH

(Doulati Ardejani, 2003; Doulati

Ardejani *et al.*, 2004)

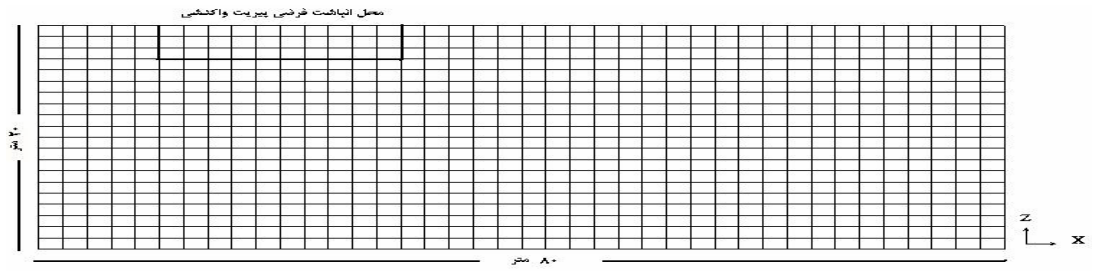
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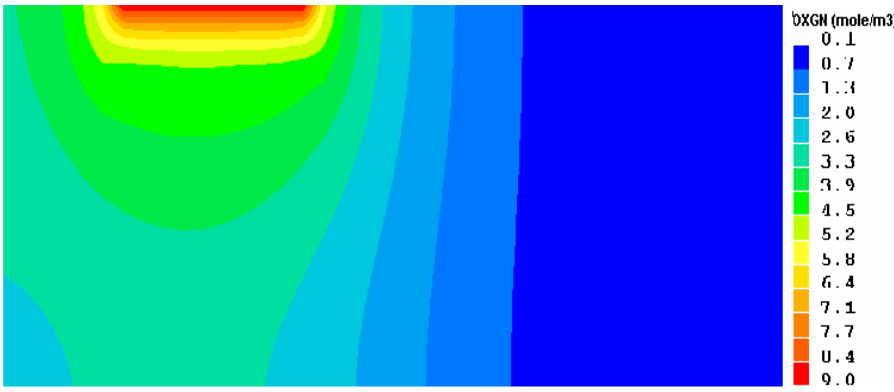
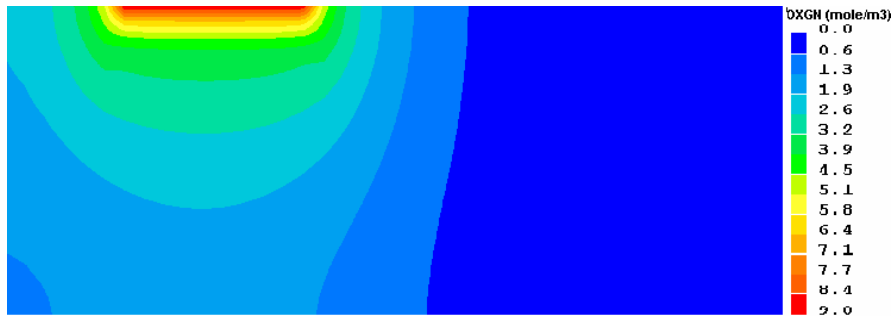
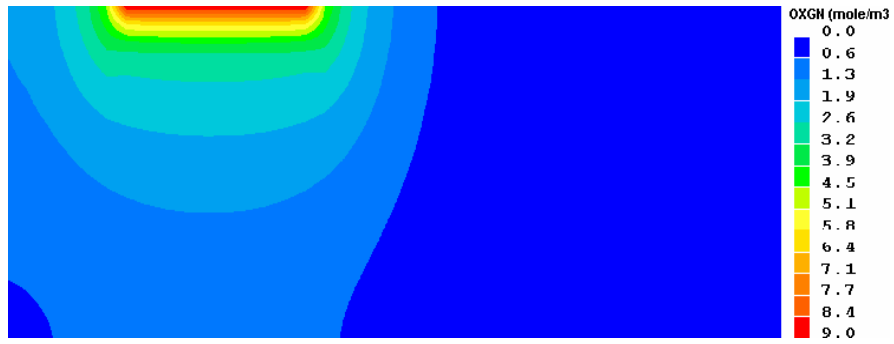
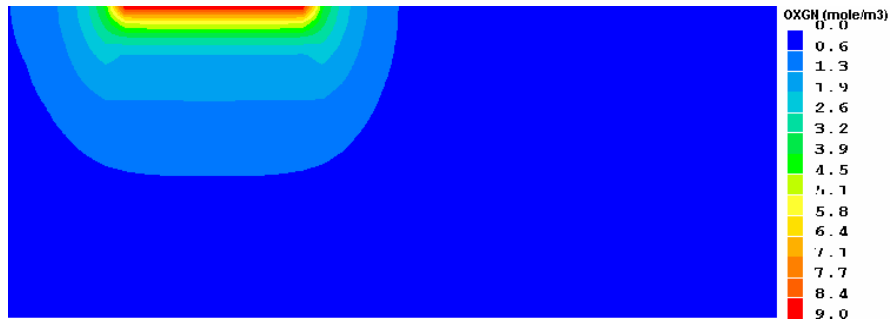
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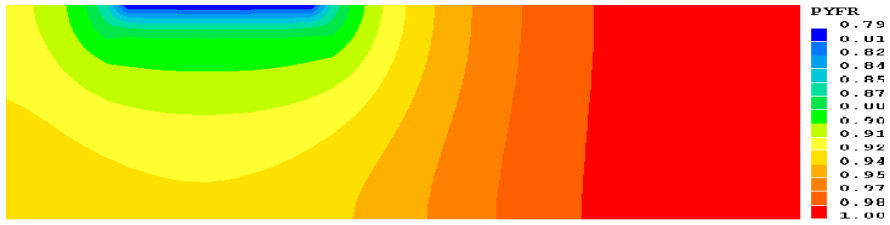
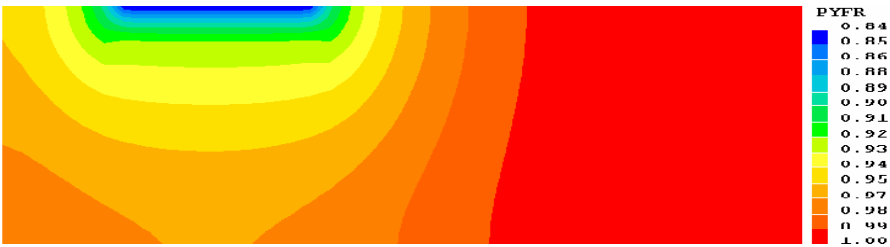
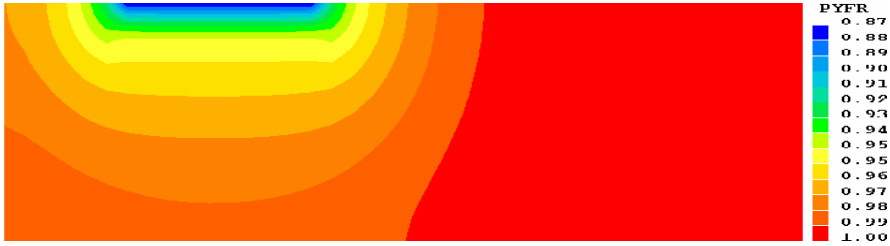
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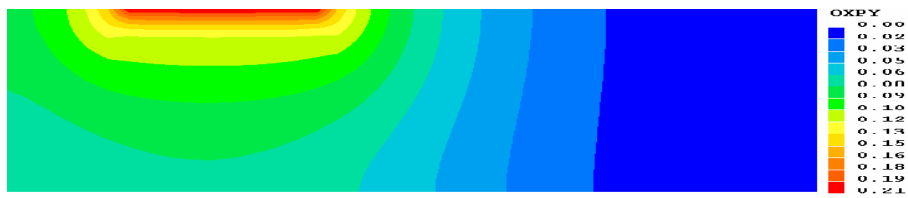
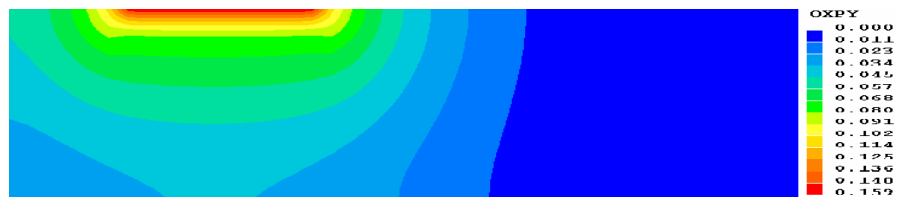
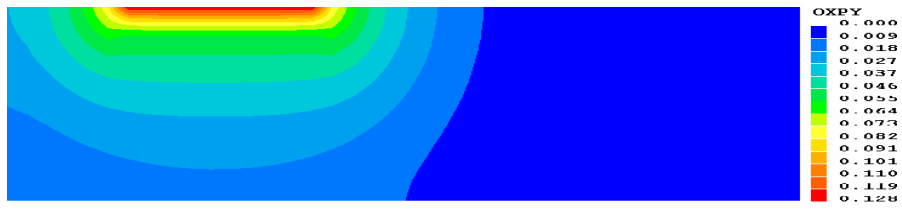
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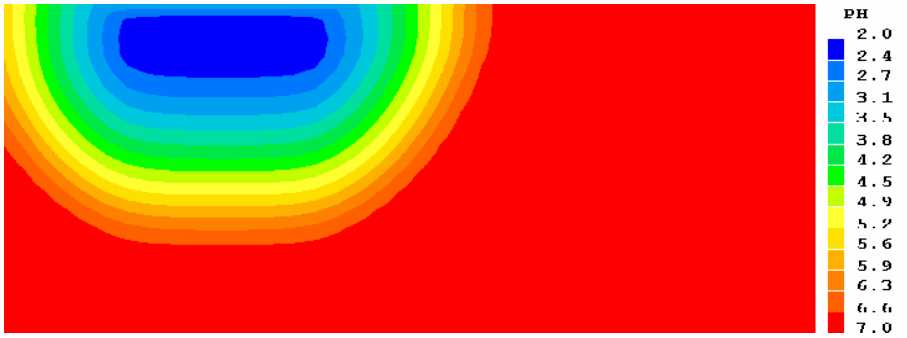
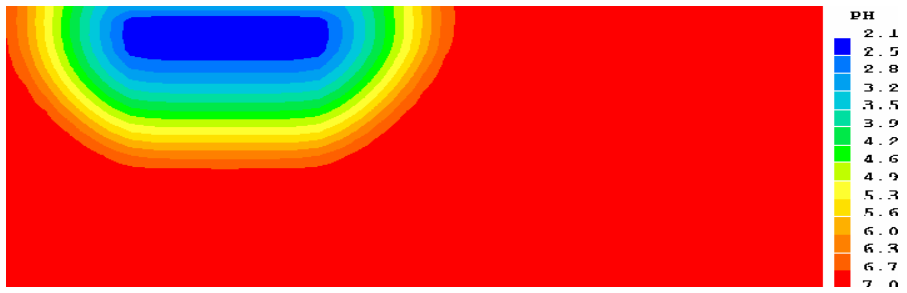
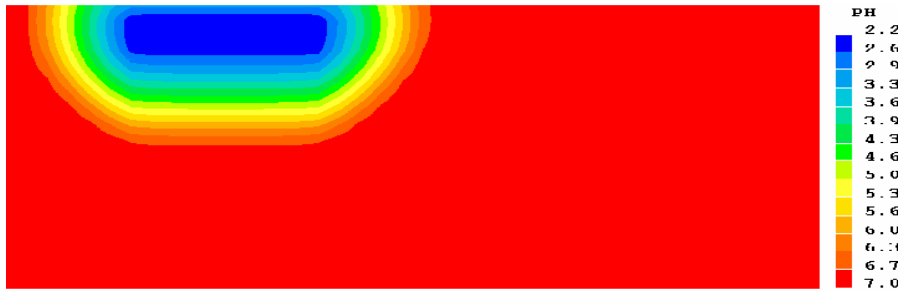
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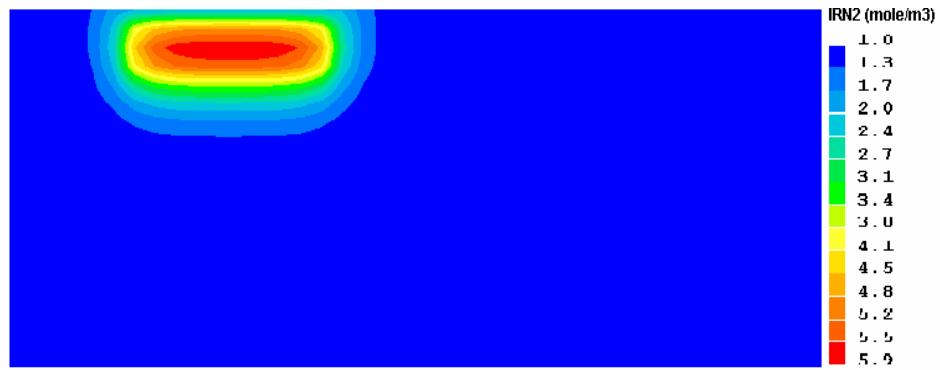
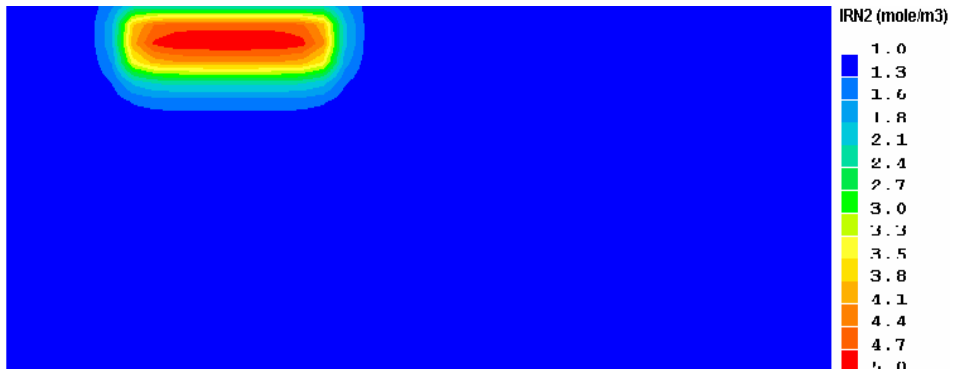
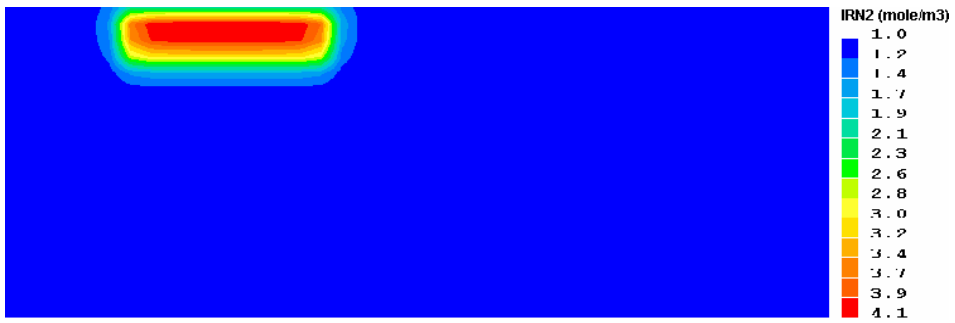
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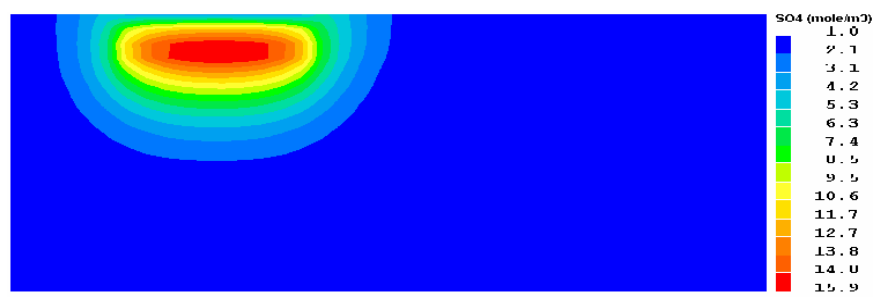
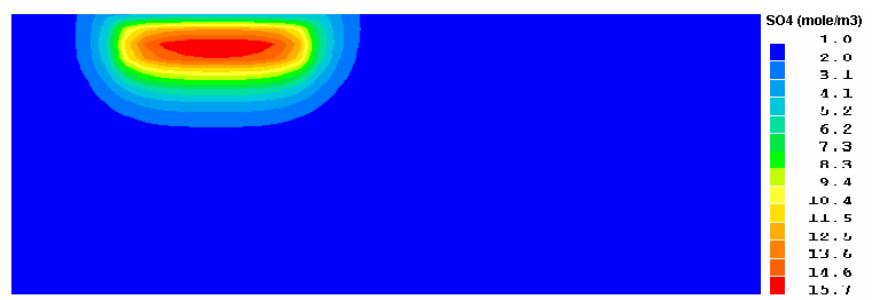
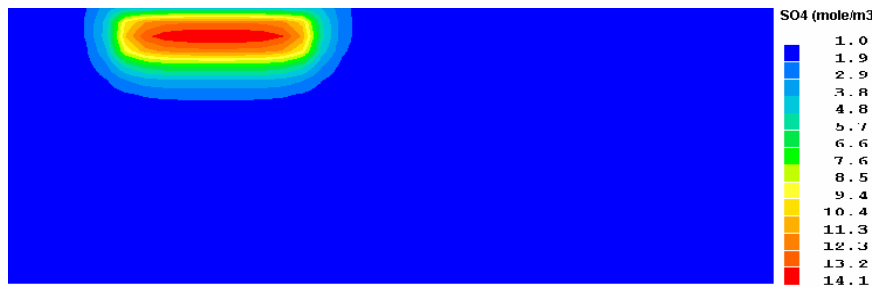


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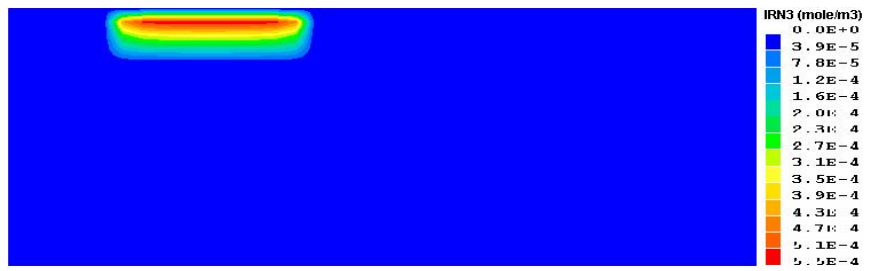
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(Singh and Atkins, 1985)

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(Doulati Ardejani, 2003)

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Abstract

Mining sector has a significant role in economy of any country. Moreover, mining operations can cause the various environmental problems such as the contamination of surface and groundwater, soil pollution, the death of creatures and the detrimental impacts on human life. Whenever, the mining operations are carried out below the groundwater table, the large amount of groundwater from the surrounding strata will flow towards the mining excavation. This effect can create a number of water related problems affecting in design, safety, erosion of mining equipments, and economic viability of the mining operations. Prediction of groundwater inflow into open mines and the establishment of an appropriate dewatering system is one of the main problems for designing and development of mining operation. Once pumping has stopped and the mine has been completed, the water level will return to its equilibrium position or original level prior to mining operations. Where the groundwater covers the materials containing pyrite, it becomes contaminated. As a result of the mining operations, the huge volume of the waste are produced that the appropriate management of these wastes is one of the major problems in environmental point of view. These wastes include the overburden waste, dump, mineral processing wastes, tailing and waste dumps. The oxidation of the sulfide minerals, mainly pyrite, in waste dumps of iron mines is an essential environmental problem. In the presence of oxygen and water, the pyrite is oxidized and the acid mine drainage (AMD) is generated. The discharge of the AMD into surface and groundwater resources can make some harmful environmental problems. The main characteristics of the AMD are high concentrations of sulfate and heavy metals, concentration of Fe^{+2} and low pH.

Since the comprehensive environmental studies have not been done in Iranian mines, therefore such studies in an iron mine are the main objective of this research. Sangan Iron Mine which is known as the second largest iron mine in Iran; is located at 300 km in southeast of Mashhad. The most important objectives of this research in the study area have been formulated as follows:

- Modeling of the groundwater inflow into pit of the North C anomaly
- Modeling of the groundwater rebound in pit of the North C anomaly
- Modeling of the pyrite oxidation, acid generation and transportation of the oxidation product's from the waste dump of the North C anomaly.

To achieve the goals, the performed studies at the present research have been presented as bellow: after performance the literature review in the field of environmental hydrogeology in Chapter 1, in consequence, Sangan iron mine has been introduced in chapter 2. The modeling of the pumpage data has been performed in order to recognize the potentiometric surface prior to opening mine and calibration of model as well in chapter 3. In chapter 4, the prediction of groundwater inflow rate into pit of the north C anomaly and the modeling of groundwater recovery process have been done. The modeling of the pyrite oxidation and generation of AMD have been studied in chapter 5. Finally, the obtained results and suggestions have been brought in chapter 6.

Keywords: Environmental hydrogeology, pit, groundwater, confined aquifer, acid mine drainage, numerical model, waste dump, Sangan iron mine.