iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** IV **Month of publication:** April 2017

DOI: http://doi.org/10.22214/ijraset.2017.4045

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Propagation of Exploding Uniform Strong Cylindrical Shock Wave in Condensed Medium (Water)

Manoj Kumar Mishra[1], Satyendra Prakash[2], Dharmendra Singh[3], Dr. P. S. Rawat[4]
[1,2,3,4]*Deptt. Of Physics, D.S.B. Campus, Kumaun University, Nainital (U.K.)*

Abstract: The very well-known theory of the shock dynamics, Chester - Chisnell- Whitham method is applied to study the exploding i.e., diverging wave in condensed medium, the water is assumed to be the simplesed form of condensed medium. The analytical shock velocity and shock strength are obtained for two cases viz, (i) when propagates freely i.e., effect of overtaking disturbances is negligible and (ii) when it moves under the influence of overtaking disturbances.
Finally, flow variables of the medium perturbed by strong cylindrical shock are obtained and discussed with the help of figures and tables for both the cases. The results obtained here are compared with those obtained by Sharma et.al.

I. INTRODUCTION

The study of blast wave propagation is now-a-days the target of scientist and medical doctors who are using shock wave treatment as tools. Due to its medical and technical applications, many techniques have been used to study the propagation of shock waves in water/liquids by researchers.. A large effort has been made to the understanding of this area in the recent past. Among possible experimental tools for studying these processes, shock tubes are very convenient ones, since they allow for easier diagnostic than any other experimental facility ,Vetter and Sturtevant –1995, Houses and Chemouni 1996, Jaurden et al.-1997,. Picone and Baris (1988), Yang et al.(1994), Yadav et al.(1996), Grasso and Pirozzoli (2000), Vuong et al.(1999), Bates and Montogomery (1999) and many others shared several features ,including the theoretical and computational studies.

The motion of converging cylindrical shock waves in a perfect gas with constant ratio specific heats has been studied by **Stanyukovich (1960)** using similar solutions. The propagation of spherically converging shock in various metals has been studied by Yadav and Singh (1982) **by** Whitham method. The shock wave propagation in water has been studied by Bhatnager et al.(1969), Singh(1972), Rango rao and Ramanna (1973), Singh et al.(1980), Singh and Shrivastava (1985) without taking gravity of earth. Viswakarma et al.(1988) considered earth's gravitation and time dependant energy release. The analysis are completely analytical and are used for diverging shock only. The diverging shock propagation in uniform and non-uniform gas has been studied by Yadav (1992), Yadav and Tripathi (1995) considering the effect of overtaking disturbances.These results are in good agreement with experimental results.

Chisnell (1998) described analytically the motion of converging spherical and cylindrical shock waves in an ideal gas. Vuong et al.(1999) has studied strong spherical converging shock by considering sonoluminiscence phenomenon using compressible Navier-shocks equations. Recently, application of spherical micro-shock waves in Biological science has been discussed by Jagdeesh and Takayama(2002). Recently, Yadav and Gangwar (2003) have used Chester (1954)- Chisnell (1953)- Whitham (1958) method to study the propagation of strong spherical shock in non-uniform medium neglecting the effect of overtaking disturbances. Being an important phenomenon, it is essential to take into account the effect of overtaking disturbances in the motion of shock waves. The effect of overtaking disturbanes,on the propagation of shock waves in water has been studied by Yadav and coworkers (2004).

Thomas(1957) used 'Energy hypothesis' for spherical blast waves. This hypothesis was successfully applied by Bhutani(1966) to cylindrical blast waves in Magnetogasdynamics. A theoretical study of explosion in water (without considering the effect of gravity) is carried out by Singh and vola (1976) using Energy hypothesis. Experimental verification of Energy hypothesis is given by Singh et al. (1980). Singh (1982) used energy hypothesis to explosion problem in seawater considering the effect of gravity was used by Vishvakarma et al. (1988). This hypothesis has been successfully applied for the determination of entropy due to the propagation of blast wave in seawater and in the propagation of blast wave in the air Yadav et al.(2005, 2006). Very recently Sharma et al. (2008) studied the flow variables of seawater due to the propagation of blast wave using the energy hypothesis of Thomas.

The water is assumed to be simplest of condensed medium. The aim of present paper is to study the strong exploding cylindrical shock in uniform condensed medium. Assuming region where explosion occours, is of uniform density, analytical relations for mach number are obtained for freely propagation of shock using Chester - Chisnell- Whitham . The effect of overtaking disturbances is included by Yadav.

It is found that shock strength decreases with propagation distance whereas it increases with refractive index.The effect of overtaking disturbances are to enhance the shock strength. Again it is found that the pressure and the particle velocity decreases with propagation distance as well as with refractive index. Similar results are reported by Sharma et al. (2008). The effect of overtaking disturbances to reduce the pressure very much, where as it decreases with refractive index.The effect of overtaking is to enhanace the shock strength.

II. BASIC EQUATIONS AND BOUNDRY CONDITIONS

A. The basic Equations for Cylindrical Shocks are

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial r} + \frac{1}{\rho}\frac{\partial P}{\partial r} = 0 \quad (1)$$

$$\left\{\frac{\partial}{\partial t} + u\frac{\partial}{\partial r}\right\}\rho + \rho\left\{\frac{\partial u}{\partial r} + \alpha\frac{u}{r}\right\} = 0 \quad (2)$$

$$\left\{\frac{\partial}{\partial t} + u\frac{\partial}{\partial r}\right\}\left(P\rho^{\gamma}\right) = 0 \quad (3)$$

where, $u(r,t)$, $P(r,t)$ and $\rho(r,t)$, are the particle velocity, the pressure and the density at distance r from the origin at time t, respectively and α =1 for cylindrical shock.

III. BOUNDRY CONDITIONS

Let p_0 and ρ_0 denotes the unperturbed values of pressure and density infront of the shock and P and ρ be the values of respective quantities at any point immediately after passes of shock, then the Rankine-Hugoniet conditions will permit us to express , P ρ and u in terms of unperturbed values of the quantities by means of the following equations,

$$u = \frac{2a_0}{(n+1)}\left(M - \frac{1}{M}\right) \quad (4a)$$

$$P = \rho_0 a_0^2\left[\frac{2M^2}{(n+1)} - \frac{(n-1)}{n(n-1)}\right] \quad (4b)$$

$$\rho = \rho_0\frac{(n+1)M^2}{(n-1)M^2 + 2} \quad (4c)$$

$$a_0 = \sqrt{\frac{(p_0+1)n}{\rho_0}} \quad (4d)$$

Where, M $\left(= \frac{U}{a_0}\right)$ is Mach number, U is the shock velocity, a_0 is the sound velocity in unperturbed medium and n is a constant

For strong shock waves i.e. (M>>1) the condition (4a-4d) reduces to-

$$u = \frac{2a_0 M}{n+1}$$

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

$$P = \frac{2a_0^2 M^2}{n+1}\rho_0$$

$$\rho = \frac{n+1}{n-1}\rho_0 \quad (5)$$

$$a = \rho M a_0 \left(\frac{n-1}{n+1}\right)$$

Where $a_0 = \sqrt{\frac{(p_0+1)n}{\rho_0}}$

where, $M = \frac{U}{a_0}$ is called the Mach number. ρ_0 a_0, P, ρ, n and U denote the undisturbed value of density, local sound velocity behind the shock, pressure,the density,the refractive index and shock velocity respectively.

IV. CHARACTERISTIC EQUATION

The characteristic form of flow equation For C_+disturbance gives the following

liner equation.

$$dP + \rho a du + \rho a^2 \frac{\alpha u}{u+a}\frac{dr}{r} = 0 \quad (6)$$

The characteristic form of flow equation For C_- disturbance gives the following

liner equation.

$$dP - \rho a du + \rho a^2 \alpha \frac{u}{u-a}\frac{dr}{r} = 0 \quad (7)$$

V. FOR FREELY PROPAGATION OF CYLINDRICAL SHOCK WAVES

Applying the boundary conditions given by the equation (5) to equ. (6) we get for c_+ disturbance -

$$\frac{dM}{M} + A\frac{dr}{r} = 0$$

where $A = \frac{(n+1)^2 \rho_0^2 \alpha}{2(n-1) + (n+1)\rho_0 \;\; 2 + \rho_0 (n+1)}$

On solving we get-

$$M = Kr^{-A} \quad (8)$$

This equation represents the shock strength of exploding strong cylindrical shock propagating in uniform region of water.
Now Shock Velocity

$$U = Ma_0 = Ka_0 r^{-A} \quad (9)$$

The Particle Velocity just behind the shock

$$u = \frac{2a_0}{n+1}Kr^{-A} \quad (10)$$

and the Pressure

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

$$P = \frac{2a_0^2 M^2 \rho_0}{n+1} = \frac{2a_0^2 K^2 r^{-2A}}{n+1} \rho_0 \quad (11)$$

VI. OVERTAKING DISTURBANCES

From equation(10) we get the particle velocity for disturbances-

$$u_+ = \frac{2a_0}{n+1} K r^{-A} \quad (12)$$

where $A = \dfrac{(n+1)^2 \rho_0^2 \alpha}{\left[2(n-1)+(n+1)\rho_0\right]\left[2+\rho_0(n+1)\right]}$

Again putting the value of boundry conditions given by the equation (5) on the characteristic equation(7) we get

$$\frac{dM}{M} + B\frac{dr}{r} = 0$$

Where $B = \dfrac{(n+1)^2 \rho_0^2 \alpha}{\left[2(n-1)+(n+1)\rho_0\right]\left[2-\rho_0(n+1)\right]}$

Integrating we get

$$\log M + B \log r = \log K'$$

$$M r^B = K'$$

$$M = K' r^{-B} \quad (13)$$

Now Shock Velocity

$$U = M a_0 = K' a_0 r^{-B} \quad (14)$$

The particle velocity-

$$u = \frac{2a_0}{n+1} K' r^{-B} \quad (15)$$

Pressure

$$P = \frac{2a_0^2 M^2 \rho_0}{n+1} = \frac{2a_0^2 K'^2 r^{-2B}}{n+1} \rho_0 \quad (16)$$

Now from equation(15)

$$u_- = \frac{2a_0}{n+1} K r^{-B} \quad (17)$$

In presence of overtaking disturbances the resultant particle velocity is given by-

$$du_+ + du_- = du^* = \frac{2}{n+1} dU^* \quad (18)$$

Where U^* is the resultant shock velocity in presence of overtaking disturbances.
For this we finding the values of du_+ and du_- as below

Volume 5 Issue IV, April 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

$$du_+ = \frac{2a_0}{n+1} K\left(-A\right) r^{-A-1} dr \quad (19)$$

$$du_- = \frac{2a_0}{n+1} K\left(-B\right) r^{-B-1} dr \quad (20)$$

from the equation (19), and (20), we get

$$du_+ + du_- = -\frac{2a_0}{n+1} K\left[\frac{A}{r^{A+1}} + \frac{B}{r^{B+1}}\right] dr = du = \frac{2}{n+1} dU^*$$

$$-a_0 K\left[\frac{A}{r^{A+1}} + \frac{B}{r^{B+1}}\right] dr = dU^*$$

Integrating

$$U^* = -a_0 K\left[\frac{A}{-r^A \times A} + \frac{B}{-r^B \times B}\right]$$

$$U^* = a_0 K\left[\frac{A}{r^A} + \frac{B}{r^B}\right] \quad (21)$$

U^* is the shock velocity in presence of overtaking disturbances i.e. shock velocity modified by overtaking velocity. Therefore modified shock strength will be

$$M^* = \frac{U^*}{a_0} = K\left[\frac{1}{r^A} + \frac{1}{r^B}\right] \quad (22)$$

The particle velocity in presence of overtaking disturbances-

$$u^* = \frac{2a_0}{n+1} K\left[\frac{1}{r^A} + \frac{1}{r^B}\right] \quad (23)$$

And the pressure just behind the shock in presence of overtaking disturbance-

$$P^* = \frac{2a_0^2 M^{*2}}{n+1} \rho_0 = \frac{2a_0^2}{n+1} \rho_0 K^2 \left[\frac{1}{r^A} + \frac{1}{r^B}\right] \quad (24)$$

VII. RESULTS AND DISCUSSION

A. The Shock Strength

Equation (12) represents the shock strength for freely propagation of exploding shock waves, in uniform region of water.

r	*M*
1.2	24.64826
1.3	23.85423
1.4	23.14190
1.5	22.49786
1.6	21.91165
1.7	21.3749
1.8	20.88089
1.9	20.42411
2.0	20.00000
2.1	19.60477
2.2	19.23520
2.3	18.88857
2.4	18.56255
2.5	18.25513

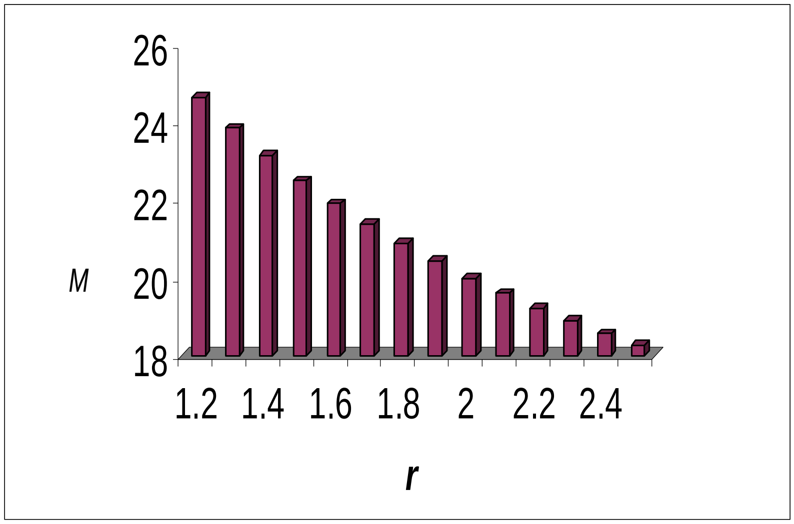


Fig.1. The variation of shock strength with propagation distance *r* for exploding strong cylindrical shock waves in uniform medium.

For the initial value of ρ_0 =1, α =1, refractive index n=1.5 and a_0 =1450, we have calculated the constant of integration from equation (11).Taking this value of constant of integration throughout, we have computed shock strength using equation (12) and presented in table 1. Changing the value of *r* from 1.2 to 2.5, the corresponding shock strength takes the values from 24.6482625 to 18.25513. It shows that as *r* increases shock strength *M* decreases slowly, while its graphical representation confirms this statement [fig 1].

Again for the initial value of ρ_0 =1, α =1, *r*=2 and changing the value of refractive index n from 1.5 to 2.8 shock strength *M* increases very slowly from 20.17076 to 21.03295 shows very less effect of refractive index *n* on shock strength *M* as shown in table 2.2.Their graphical representation is shown in fig.2 below.

n	*M*
1.5	20.17076
1.6	20.31244
1.7	20.43132
1.8	20.53207
1.9	20.61815
2.0	20.69226
2.1	20.75645
2.2	20.81239
2.3	20.86137
2.4	20.90445
2.5	20.9425
2.6	20.97622
2.7	21.00621
2.8	21.03295

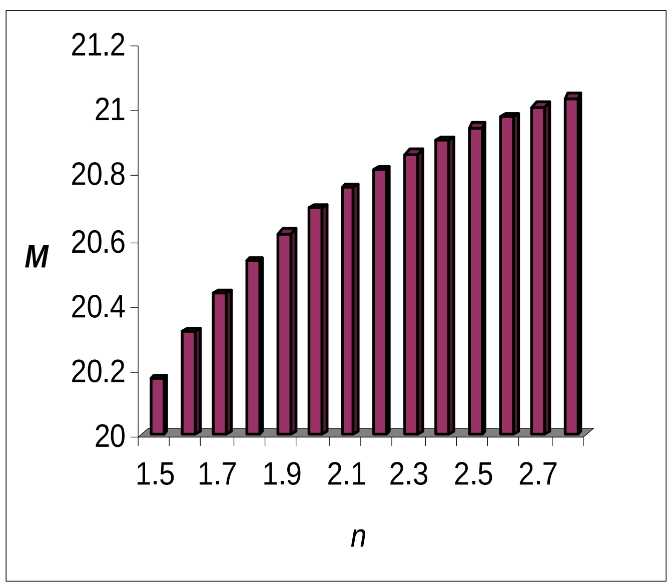


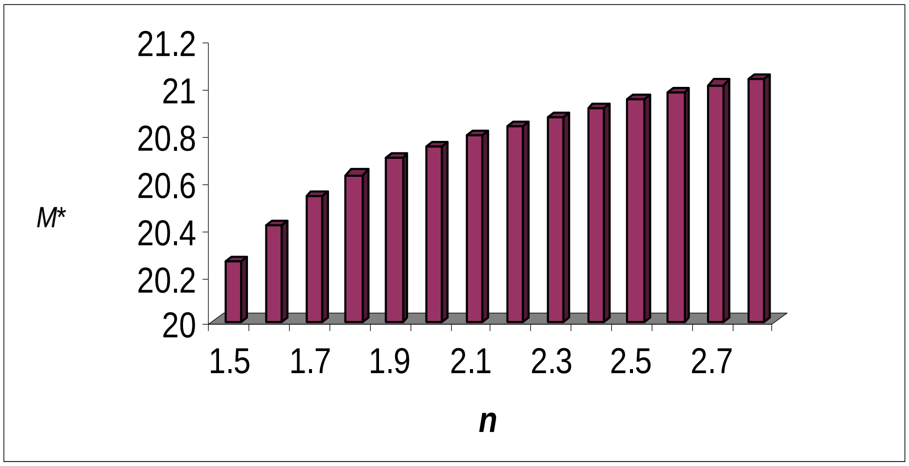
Table 2**.** The variation of shock strength M with refractive index *n* for exploding strong cylindrical shock waves in uniform medium.

Equation (22) represents the shock strength of exploding shock waves in presence of overtaking disturbances. For the initial value of

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

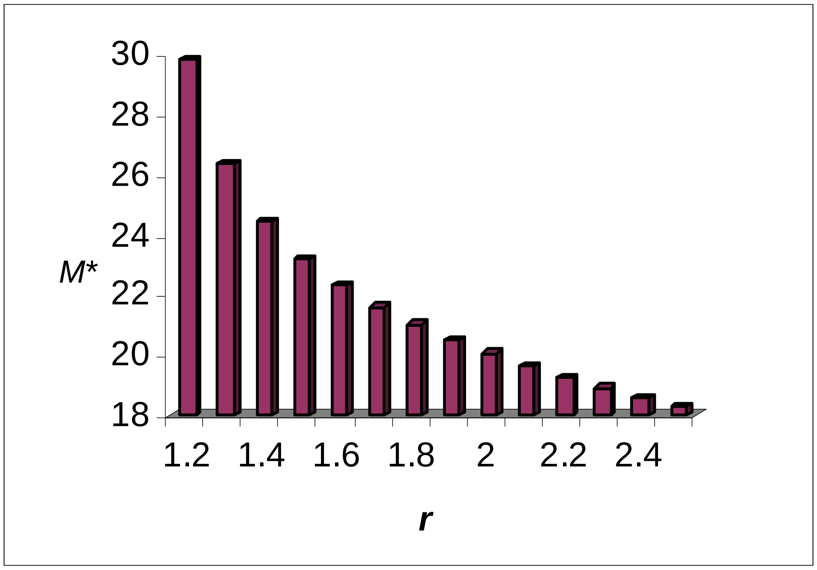
ρ_0 =1, α =1 refractive index n=1.5 and a_0=1450, the variation of shock strength of exploding cylindrical shock modified by overtaking disturbances is computed using equation(22). Changing with the value of r from 1.2 to 2.5 the corresponding to overtaking shock strength takes the value from 29.7915 to 18.26206. It shows that as r increases modified shock strength M^* (strength of the shock in presence of overtaking disturbances) decreases slowly as shown in table 3, while the graphical representation is given in fig 3.

r	*M**
1.2	29.79518
1.3	26.35854
1.4	24.42726
1.5	23.18867
1.6	22.29810
1.7	21.59884
1.8	21.01477
1.9	20.50641
2.0	20.05187
2.1	19.63820
2.2	19.25719
2.3	18.90331
2.4	18.57260
2.5	18.26209



Tab. 3 The variation of modified shock strength M^* with propagation distance r for exploding strong cylindrical shock waves in uniform medium

r	*M**
1.2	29.79518
1.3	26.35854
1.4	24.42726
1.5	23.18867
1.6	22.2981
1.7	21.59884
1.8	21.01477
1.9	20.50641
2.0	20.05187
2.1	19.63820
2.2	19.25719
2.3	18.90331
2.4	18.57260
2.5	18.26209



Tab. 3 The variation of modified shock strength M^* with propagation

Distance r for exploding strong cylindrical shock waves in uniform medium

In presence of overtaking disturbances the modified shock strength is computed ,we conclude that the value of overtaking shock strength M^* is increases from 20.2531 to 21.03295 as n increases from 1.5 to 2.8 as shown in table 2.4 while the graphical representation in is shown fig .4.

n	*M**
1.5	20.25310
1.6	20.41281
1.7	20.53427
1.8	20.62449
1.9	20.69176
2.0	20.74412
2.1	20.78823
2.2	20.82873
2.3	20.86800
2.4	20.90636
2.5	20.94282
2.6	20.97624
2.7	21.00621
2.8	21.03295

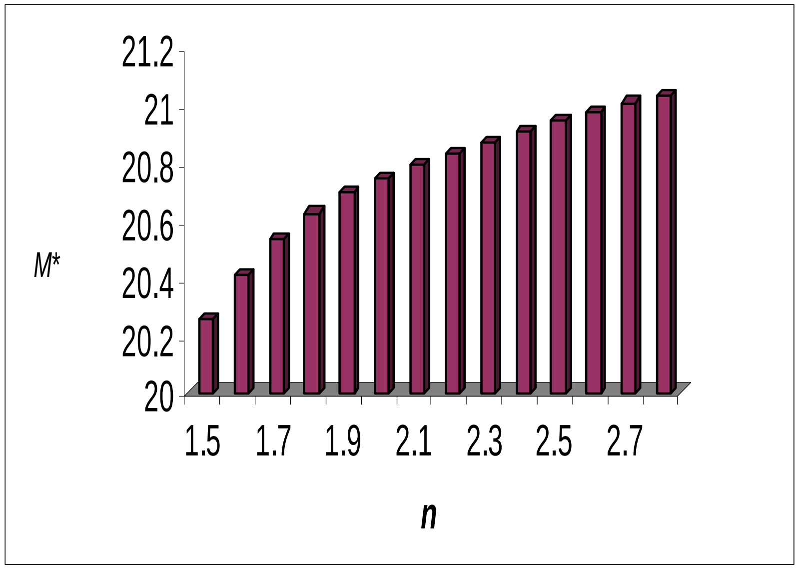


Table. 4 The variation of modified shock strength *M** with refractive index *n* for exploding strong cylindrical shock waves in uniform medium.

B. The Shock Velocity Equation (2.13) represents the Shock Velocity U for Freely Propagation of Exploding Shock Waves in Uniform Region of Water

For the initial value of ρ_0 =1, α =1, refractive index n=1.5 and a_0 =1450, we calculate the constant of integration from equation (8). Taking this value of constant of integration throughout, we have computed shock velocity using equation (9) and presented in table 5. Changing with the value of *r* from 1.2 to 2.5 the corresponding shock velocity takes the value from 8133.926 to 6024.194 respectively. It shows that as *r* increases shock velocity *U* decreases slowly, while its graphical representation conforms this statment [fig 5].

r	*U*
1.2	8133.926
1.3	7871.897
1.4	7636.826
1.5	7424.295
1.6	7230.843
1.7	7053.717
1.8	6890.693
1.9	6739.955
2.0	6600.000

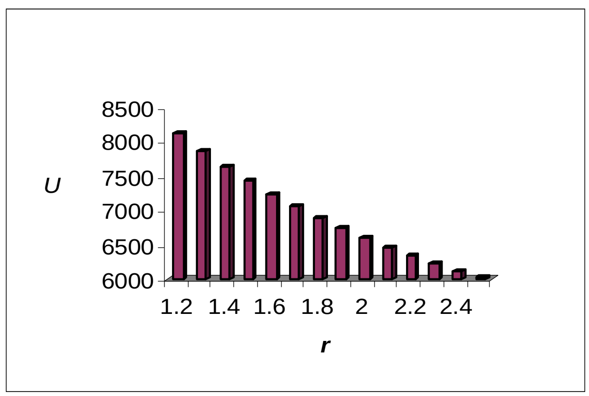


Table:5 The variation of shock velocity *U* with propagation distance *r* for exploding cylindrical shock waves in uniform medium.

Again for the initial value of ρ_0 =1, α =1, *r*=2 and changing the value of refrative index n from 1.5 to 2.8 .We conclude that the value of shock velocity *U* increasing fastly from 6656.3521 to 6940.873 shows good effect of refrative index *n* . variation of shock velocity *U* with refractive index n is shown in table 6. Their graphical representation is shown in fig. 6.

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

n	*U*
1.5	6656.351
1.6	6703.104
1.7	6742.337
1.8	6775.582
1.9	6803.99
2.0	6828.444
2.1	6849.63
2.2	6868.088
2.3	6884.252
2.4	6898.469
2.5	6911.024
2.6	6922.153
2.7	6932.048
2.8	6940.873

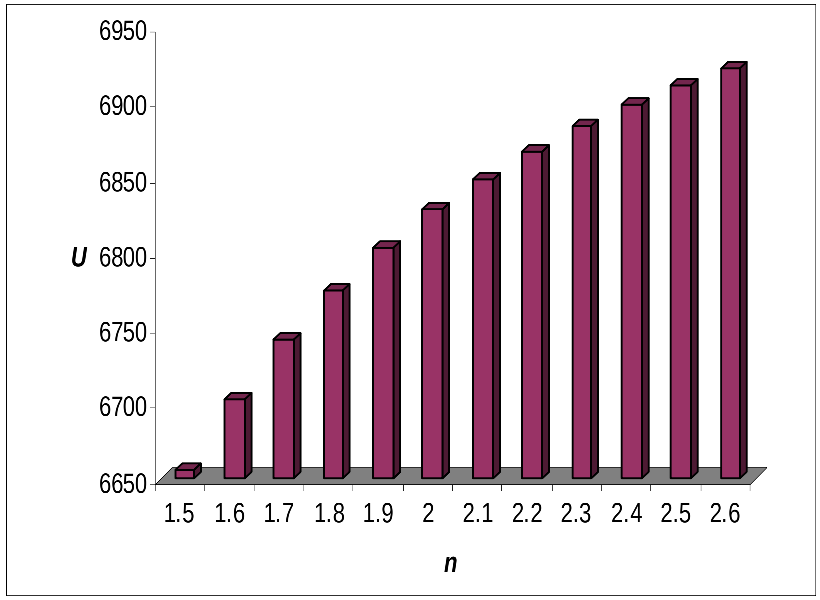
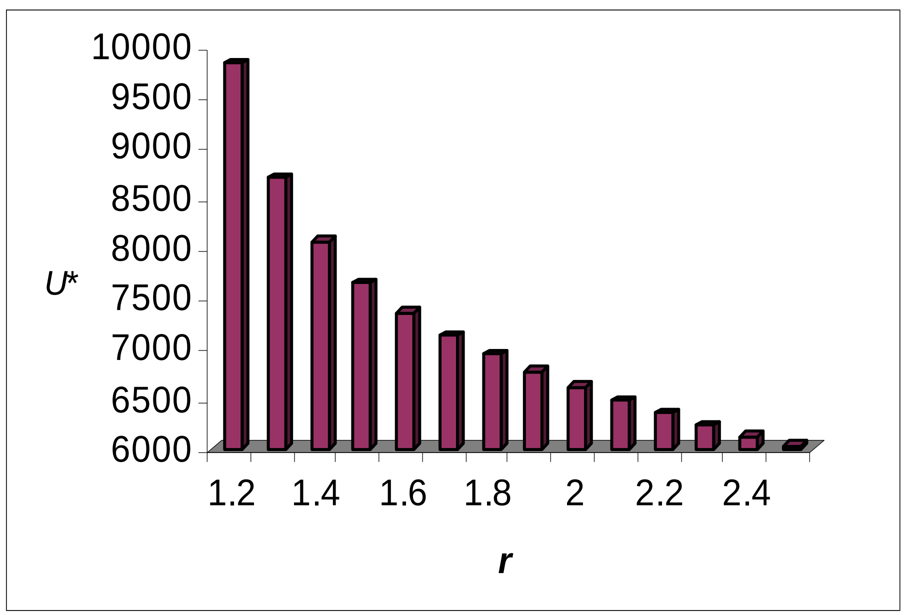


Table. 6 The variation of shock velocity *U* with refractive index n for exploding strong cylindrical shock waves in uniform medium.

Equation (21) represents the shock velocity *U** of exploding shock waves in presence of overtaking disturbances. For the initial value of ρ_0 =1, α =1 refractive index n=1.5 and a_0=1450, the variation of shock velocity *U** of exploding cylindrical shock modified by overtaking disturbances is computed using equation(2.26). Changing with the value of *r* from 1.2 to 2.5 the corresponding to overtaking shock velocity *U** takes the value from 9832.41to 6026.491. While the graphical representation is given in fig 7. It shows that as *r* increases modified shock velocity *U** (strength of the shock in presence of overtaking diturbances) decreases very fastly as shown in table 7,while its graphical representation is shown in fig 7.

r	*U**
1.2	9832.41
1.3	8698.32
1.4	8060.997
1.5	7652.262
1.6	7358.373
1.7	7127.618
1.8	6934.875
1.9	6767.114
2.0	6617.117
2.1	6480.606
2.2	6354.874
2.3	6238.093
2.4	6128.959
2.5	6026.491



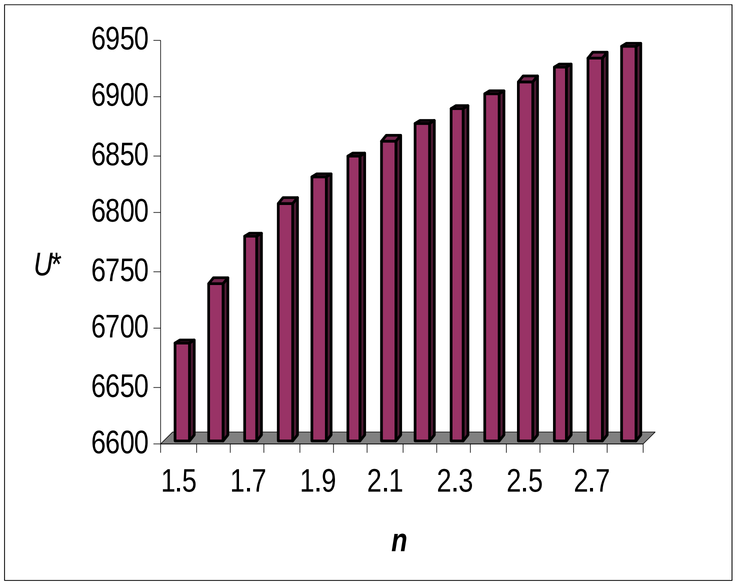
Tab. 7 the variation of shock velocity *U** modified by overtaking disturbances with propagation distance *r* for exploding strong cylindrical shock waves in uniform medium.

In presence of overtaking disturbances the shock velocity *U** is computed. We conclude that the values of shock velocity *U**,

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

changing with the value of *n* from 1.5 to 2.8 the corresponding overtaking shock velocity *U** takes the value from 66835.522 to 6940.873. We concluded that as *n* increases overtaking shock velocity *U** is also increases slowly as shown in table 8, while its graphical representation is given in fig 8.

n	*U**
1.5	6683.522
1.6	6736.226
1.7	6776.311
1.8	6806.08
1.9	6828.282
2.0	6845.561
2.1	6860.115
2.2	6873.48
2.3	6886.441
2.4	6899.1
2.5	6911.131
2.6	6922.16
2.7	6932.048
2.8	6940.873



Tab. 8 The variation of shock velocity *U** modified by overtaking disturbances with refractive index *n* for exploding strong cylindrical shock waves in uniform medium.

C. The Particle Velocity

Equation (10) represents the particle velocity for freely propagation of exploding shock waves, in uniform region of water.

For the initial value of ρ_0 =1, α =1 refractive index n=1.5 and a_0 =1450, we have calculated the constant of integration from equation (8).Taking this value of constant of integration throughout, we have computed particle velocity *u* using equation (10) and presented in table 9.Changing with the value of *r* from 1.2 to 2.5 the corresponding from particle velocity takes the value from 6778.272 to 5020.161 respectively. We concluded that the particle velocity *u* decreases very sharply. While the graphical representation conform this statement [fig 9].

r	*u*
1.2	6778.272
1.3	6559.914
1.4	6364.022
1.5	6186.913
1.6	6025.703
1.7	5878.097
1.8	5742.244
1.9	5616.629
2.0	5500.000
2.1	5391.310
2.2	5289.679
2.3	5194.357
2.4	5104.702

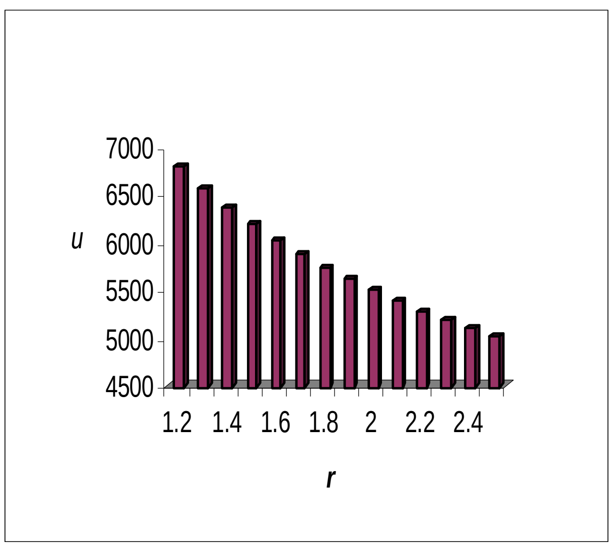


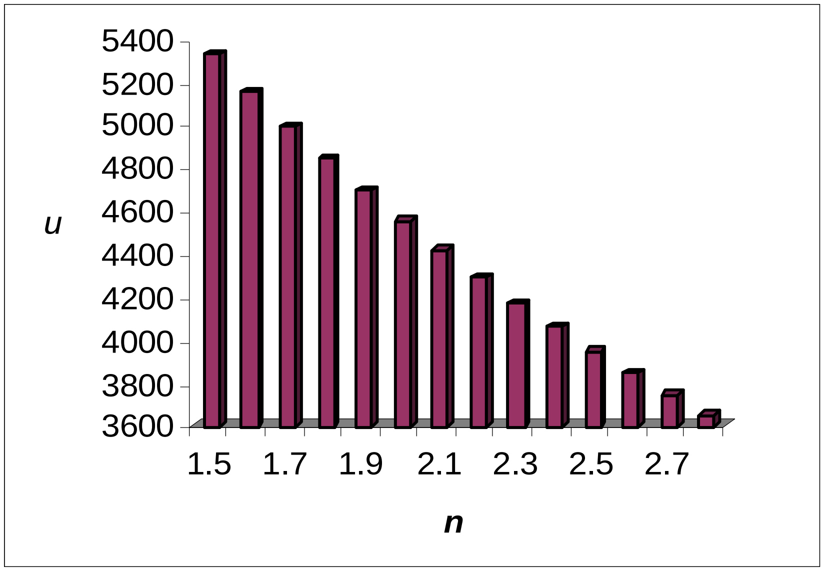
Table 9 the variation of particle velocity *u* with propagation distance *r* for exploding strong cylindrical shock waves in uniform

Volume 5 Issue IV, April 2017
ISSN: 2321-9653

medium.

Again for the initial value of $\rho_0 = 1$, $\alpha = 1$, r=2, we calculated the constant of integration. With changing the value of refractive index *n* from 1.5 to 2.8 the value of particle velocity *u* decreasing fastly from 5325.081 to3653.091 shows good effect of refractive index *n* to the particle velocity *u*.Variation of particle velocity *u* with refractive index n is shown in table 10.While it's graphically representation is shown in fig. 10.

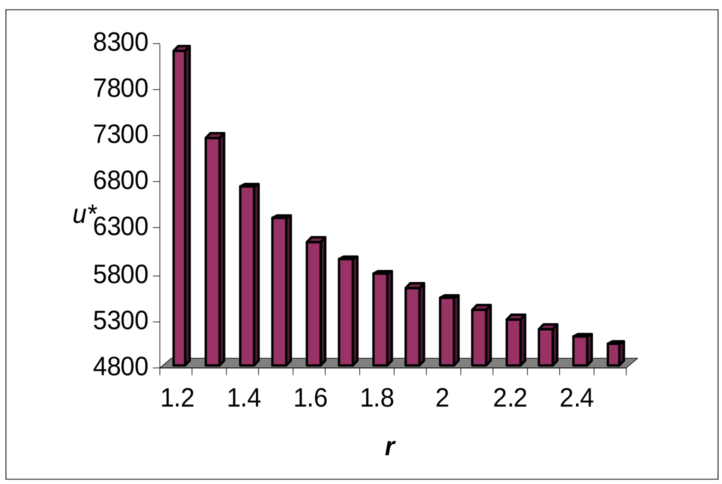
n	*u*
1.5	5325.081
1.6	5156.234
1.7	4994.324
1.8	4839.701
1.9	4692.407
2.0	4552.296
2.1	4419.116
2.2	4292.555
2.3	4172.274
2.4	4057.923
2.5	3949.157
2.6	3845.64
2.7	3747.053
2.8	3653.091



Tab. 10 the variation of particle velocity *u* with refractive index n for exploding strong cylindrical shock waves in uniform medium.

Equation (23) represents the particle velocity of exploding shock waves in presence of overtaking disturbances. For the initial value of ρ_0 =1, α =1 refractive index n=1.5 and a_0=1450, the variation of particle velocity u of exploding cylindrical shock modified by overtaking disturbances is computed using equation(21). Changing with the value of *r* from 1.2 to 2.5 the corresponding to modified particle velocity *u** (strength of the shock in presence of overtaking disturbances) takes the value from 8193.675 to5022.076 it shows that the modified particle velocity *u** decreases very fastly as shown in table 11, while its graphical representation is given in fig 11.

r	*u**
1.2	8193.675
1.3	7248.600
1.4	6717.497
1.5	6376.885
1.6	6131.978
1.7	5939.682
1.8	5779.062
1.9	5639.262
2.0	5514.264
2.1	5400.505
2.2	5295.728



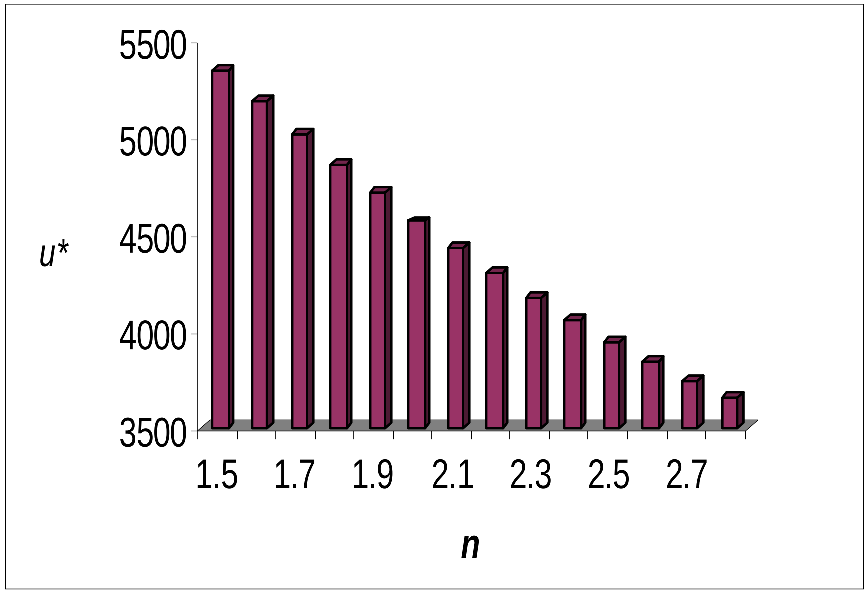
Tab. 11 the variation of modifiedparticle velocity *u** with propagation distance *r* for exploding strong cylindrical shock waves in uniform medium.

In presence of overtaking disturbances the particle velocity *u** is computed. We conclude that the value of overtaking particle velocity *u** is increases from 5346.818 to 3653.091respectively. we concluded that as n increases from 1.5 to 2.8, overtaking

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

particle velocity u^* is decreases slowly as shown in table 12,while its graphical representation is shown in fig 12.

n	u^*
1.5	5346.818
1.6	5181.712
1.7	5019.489
1.8	4861.486
1.9	4709.16
2	4563.707
2.1	4425.881
2.2	4295.925
2.3	4173.6
2.4	4058.294
2.5	3949.217
2.6	3845.644
2.7	3747.053
2.8	3653.091



Tab.12 The variation of modified particle velocity u^* with refractiveindex n for exploding strong cylindrical shock waves in uniform medium.

D. The Pressure

Equation (11) represents the pressure P for freely propagation of exploding shock waves, in uniform region of water.

For the initial value of ρ_0 =1, α =1 refractive index n=1.5 and a_0=1450, we have calculated the constant of integration from equation (8).Taking this value of constant of integration throughout, we have computed pressure P using equation (11) and presented in table13. Changing the value of r from 1.2 to 2.5 the corresponding takes the value from 55133967 to 30242425 respectively. It shows that as r increases pressure P decreases very fastly, while its graphical representation confirms this statement [fig 13].

r	P
1.2	55133967
1.3	51638963
1.4	48600931
1.5	45933467
1.6	43570911
1.7	41462432
1.8	39568043
1.9	37855829
2.0	36300000
2.1	34879474
2.2	33576845
2.3	32377608
2.4	31269574
2.5	30242425

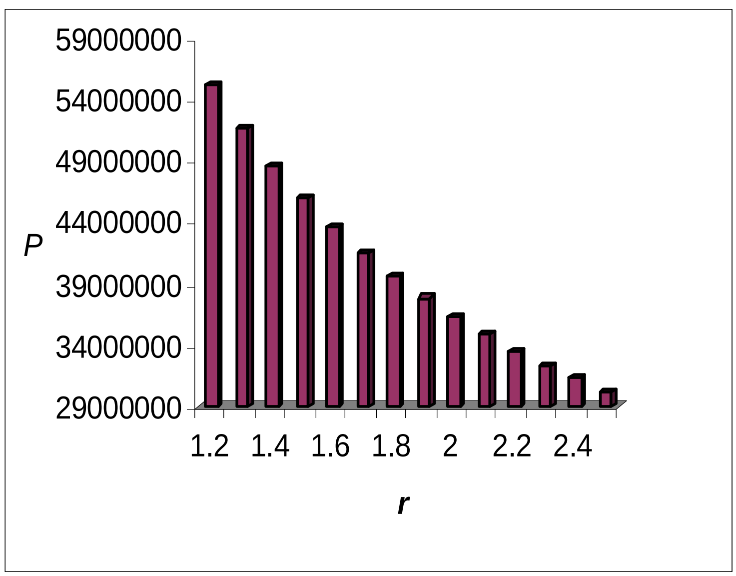


Table 13 the variation of pressure P with propagation distance r for exploding strong cylindrical shock waves in uniform medium.

Again for the initial value ρ_0 =1, M=20, α =1, r=2, with changing the value of refractive index n from 1.5 to 2.8 of pressure P decreases very fastly from 35445608 to 25355638. From above discussion we concluded that as far as the refractive index n

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

increases the pressure P takes the lower value as shown in table 14. Their graphical representation is shown in fig.14.

n	P
1.5	35445608
1.6	34562768
1.7	33673411
1.8	32791791
1.9	31927092
2	31085101
2.1	30269310
2.2	29481648
2.3	28722982
2.4	27993454
2.5	27292720
2.6	26620111
2.7	25974752
2.8	25355638

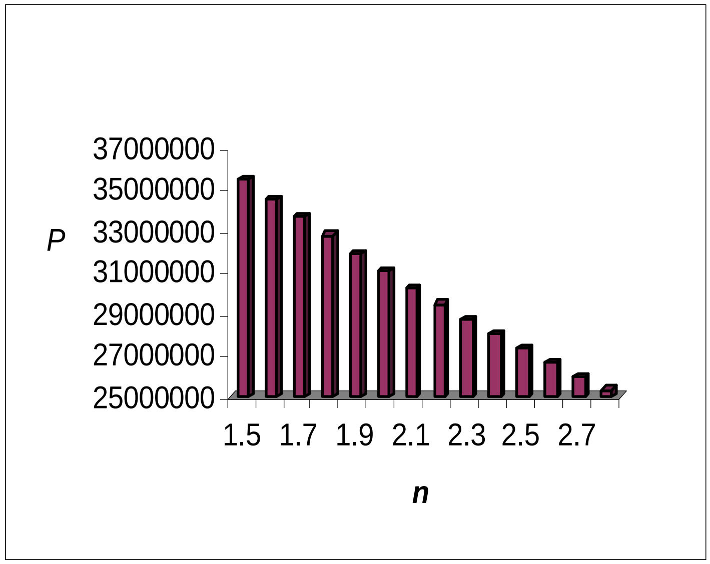


Table 14 The variation of pressure P with refractive index n for exploding strong cylindrical shock waves in uniform medium.

Equation (24) represents the pressure P^* of exploding shock waves in presence of overtaking disturbances. For the initial value of ρ_0 =1, α =1, refractive index n=1.5 and a_0=1450, the variation of pressure P^* of exploding cylindrical shock modified by overtaking disturbances is computed using equation(24). Changing with the value of r from 1.2 to 2.5 the corresponding to modified pressure P^* (strength of the shock in presence of overtaking disturbances) takes the value from 22.13081 to 22.13081,Shows that the modified pressure P^* does not depend on the variation of propagation distance r overtaking pressure P^* as shown in table 15,while its graphical representation is given in fig 15.

r	P^*
1.2	22.13081
1.3	22.13081
1.4	22.13081
1.5	22.13081
1.6	22.13081
1.7	22.13081
1.8	22.13081
1.9	22.13081
2	22.13081
2.1	22.13081
2.2	22.13081
2.3	22.13081
2.4	22.13081
2.5	22.13081

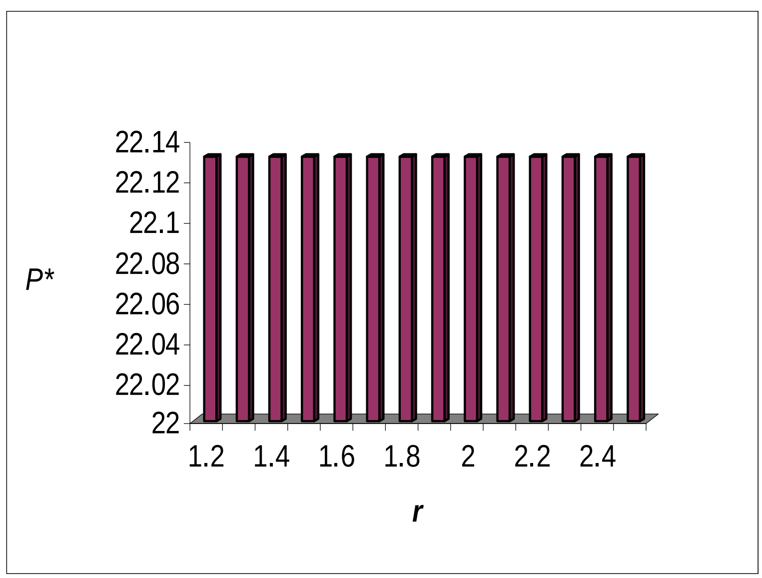


Table 15 The variation of pressure P^* modified by overtaking disturbances with propagation distance r for exploding strong cylindrical shock waves in uniform medium.

In presence of overtaking disturbances the pressure P^* is computed. We conclude that the value of overtaking shock pressure P^* is increases from 21.24558 to 13.97736 when the refractive index *n* changing from 1.5 to 2.8 as shown in table 16. While its graphically representation is given in the fig. 16.

n	*P**
1.5	21.24558
1.6	20.42844
1.7	19.67183
1.8	18.96927
1.9	18.31516
2	17.70465
2.1	17.13353
2.2	16.59811
2.3	16.09514
2.4	15.62175
2.5	15.17542
2.6	14.75388

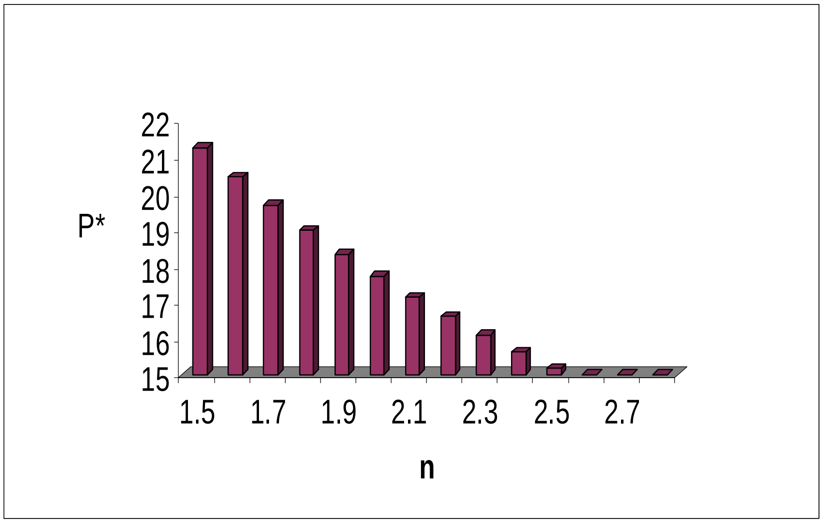


Table 16 The variation of pressure *P** modified by overtaking disturbances with refractive index *n* for exploding strong cylindrical shock waves in uniform medium.

REFERENCES

[1] Bates. J.W. and Montgomery, D.C. : (1999) Phy. Fluid, 11(2), 46
[2] Bhatnager, P.L;Sachadev, P.L. : (1969) J.Fluid.Mech.,39, 587 and Prasad Phoolan
[3] Bhutani, O.P. : (1966), J. Math.Anal. Applic., 13, 565-576.
[4] Chester, W. : (1954) Philos. Mag. 45(7): 1293
[5] Chisnell, R.F. : (1955) Proc. Roy. Soc. A. 223: 350
[6] Chisnell, R.F. : (1998) J. Fluid. Mech. 854, 375.
[7] Delius, M. and Brondel, W. : (1988) Naturwise, 75.
[8] Grasso, F. and Pinnozzoli, S. : (2000) Phy. Fluid, 22(1),205
[9] Housas, L. and Chemouni I. : (1996) Phy. Fluid, 8, 614
[10] Jagdeesh, G. and Takayama, K. : (2002)J.Ind. Inst. Sci; 82,99
[11] Jourden, G.;Housas, L; Hass. : (1997) J. Fluid.Mech., 349,67J.F and Bendor, G
[12] Picon, J.M. and Baris, J.P. : (1998) Fluid Mech., 189, 23
[13] Ranga Rao, M.P. Ramanna, B.V. : (1973) Int. J. Engg., Sci., 1317
[14] Singh J.B. and Srivastava, S.K. : (1985) Modelling Simulation and control, B.2, 18
[15] Singh, V.P. : (1972) Indian J. Phy., 46, 547
[16] Singh V.P. and Madan, A.K. : (1980) Pro. Acad. Sci (Engg. Sci.), 3, 169
[17] Singh, V.P. : (1982). Def. Sci., J., 32, 327-332.
[18] Singh, V.P.; Madan, A.K.; Suneja : (1980), Proc. Ind. Acad. Sci., (Engg. Sci.),S.R.; Lal 3,169-175.
[19] Singh, V.P. and Bola, M.S. : (1976) Ind. J. Pure Appl. Math.7 no. 12, 1405-1410.
[20] Stanyukovich, K.P. : (1960) Unsteady Motion of Continuous Media Academic Press, NY
[21] Stanyukovich, K.P. : (1960) Unsteady Motion of Continuous Media Academic Press, NY
[22] Thomas, T.Y : (1957) J. Math. Mech., 6, 607-620.
[23] Vetter, M. and Sturtevant, B. : (1995) Shock Waves, 4, 247
[24] Vishvakarma, J.P.; Nagar, K.S. : (1988), Def. Sci. J. 38, No. 1, 69-76. Mishra, R.B.
[25] Witham, G.B. : (1958) J.Fluid Mech., 4, 337
[26] Yadav H.S. and Singh, V.P. : (1982) Pramana, 18(4), 331
[27] Yadav R.P. and Gangwar, P.K. : (2003) J.Nat. Phy, Sci., 17(2), 109
[28] Yadav, R.P. and Tripathi, S. : (1995) Astro. Phy. Spaced, Sci., 225,67
[29] Yadav, R.P.; Agarwal , P.K. ; : (2005), entropy, 7[2], 134-147. Sharma. A.**:**(2005), entropy, 7[2], 134-147.
[30] Yadav, R.P.; Agarwal , P.K. ; : (2006), Entropy, 8, 143-168. Sharma. A.
[31] Yadav, R.P.; Tripathi,S. and Gupta, M : (1996) Ind J. Theo. Phy.44(3), 243
[32] Yadav,M. : (1992) Ph.D. Thesis, Agra