

**Figure 13:** Parameter  $\alpha$  in the growth rate scaling ( $da/dt \sim t^\alpha$ ) vs. Atwood number, measured at time  $t \sim 20$  in Fig. 13; the vertical bar represents the experimental results of Prasad et al (2000). The filled circle is from the compressible PPM simulation.

## Appendix

The literal equations for the Taylor series described in Section 2.1 was normalized and is given below. Here we have used

$$\eta^* = \sum_{p=1}^{\infty} \eta^{*(p)}(x,t), \quad (\text{where}) \quad \eta^{*(p)} = \sum_{j=1}^{j=p} \eta_j^{*(p)}(t) \cos(jkx), \quad (\text{where})$$

$$\eta^* = \eta / a_0^3, \quad \eta_j^{*(p)} = \eta_j^{(p)} / k^{n-1} a_0^3, \quad \tau = v_0 t / a_0, \quad C_j = \cos(jkx).$$

that the first term in the series was obtained by Richtmyer (1960). The second term was given first by Haan (1991) and the third and fourth terms were derived by Zhang & Sohn (1996).

$$\eta_1^* = (1 + \tau)C_1,$$

$$\eta_2^* = \frac{1}{2}(A\tau^2)C_2,$$

$$\eta_3^* = \frac{1}{24}\{-[3\tau^2 + \tau^3 + 4A^2\tau^3]C_1 + 3[-3\tau^2 - \tau^3 + 4A^2\tau^3]C_3\},,$$

$$\eta_4^* = \frac{1}{12}\{-[3A\tau^2 + 4A^3\tau^4]C_2 + [-A(4\tau^4 + 8\tau^3 - 3\tau^2) + 8A^3\tau^4]C_4\},$$

$$\eta_5^* = \left\{ \left[ \frac{\tau^2}{12} + \frac{\tau^3}{24} + \frac{1}{192}\tau^4 + \frac{1}{960}\tau^5 \right] + A^2 \left[ -\frac{1}{48}\tau^2 + \frac{7}{48}\tau^3 + \frac{11}{48}\tau^4 + \frac{1}{16}\tau^5 \right] + A^4 \left[ \frac{1}{60}\tau^5 \right] \right\} C_1$$

$$+ \left\{ \left[ \frac{3}{128}\tau^5 + \frac{15}{128}\tau^4 + \frac{9}{32}\tau^3 + \frac{7}{32}\tau^2 \right] + A^2 \left[ \frac{3}{16}\tau^5 + \frac{1}{4}\tau^4 + \frac{3}{4}\tau^3 \right] - A^4 \left[ \frac{27}{40}\tau^5 \right] \right\} C_3$$

$$+ \left\{ -\frac{5}{32}\tau^2 + \frac{5}{32}\tau^3 + \frac{35}{128}\tau^4 + \frac{7}{128}\tau^5 \right\} + A^2 \left[ \frac{5}{8}\tau^3 - \frac{5}{4}\tau^4 - \frac{37}{48}\tau^5 \right] + A^4 \left[ \frac{25}{24}\tau^5 \right] \right\} C_5$$

$$\begin{aligned}
\eta_6^* &= \left\{ A \left[ \frac{35}{192} \tau^2 - \frac{1}{8} \tau^3 + \frac{13}{96} \tau^4 - \frac{13}{120} \tau^5 - \frac{17}{720} \tau^6 \right] \right. \\
&+ A^3 \left[ \frac{15}{32} \tau^4 + \frac{19}{40} \tau^5 + \frac{1}{8} \tau^6 \right] + A^5 \left[ \frac{1}{10} \tau^6 \right] \} C_2 \\
&+ \left\{ A \left[ -\frac{7}{32} \tau^2 + \frac{29}{36} \tau^3 + \frac{7}{8} \tau^4 + \frac{2}{15} \tau^5 + \frac{11}{360} \tau^6 \right] \right. \\
&+ A^3 \left[ -\frac{23}{12} \tau^4 + \frac{9}{10} \tau^5 + \frac{277}{360} \tau^6 \right] - A^5 \left[ \frac{64}{45} \tau^6 \right] \} C_4 \\
&+ \left\{ A \left[ \frac{3}{32} \tau^2 - \frac{3}{4} \tau^3 + \frac{1}{4} \tau^4 + \frac{23}{20} \tau^5 + \frac{23}{80} \tau^6 \right] + A^3 \left[ \frac{23}{16} \tau^4 - \frac{5}{2} \tau^5 - \frac{7}{4} \tau^6 \right] + A^5 \left[ \frac{9}{5} \tau^6 \right] \right\} C_6
\end{aligned}$$

$$\begin{aligned}
\eta_7^* &= \left\{ \left[ -\frac{47}{768} \tau^2 - \frac{83}{2304} \tau^3 + \frac{13}{2304} \tau^4 - \frac{11}{1280} \tau^5 - \frac{337}{46,080} \tau^6 - \frac{337}{322,560} \tau^7 \right] \right. \\
&+ A^2 \left[ \frac{7}{256} \tau^2 - \frac{319}{2,304} \tau^3 - \frac{101}{288} \tau^4 - \frac{289}{960} \tau^5 - \frac{241}{1,920} \tau^6 - \frac{1,903}{80,604} \tau^7 \right] \\
&+ A^4 \left[ \frac{11}{576} \tau^4 - \frac{19}{320} \tau^5 - \frac{79}{960} \tau^6 + \frac{29}{2,520} \tau^7 \right] + A^6 \left[ \frac{1}{210} \tau^7 \right] \} C_1 \\
&+ \left\{ \left[ -\frac{169}{1280} \tau^2 - \frac{289}{768} \tau^3 - \frac{211}{768} \tau^4 - \frac{73}{1280} \tau^5 - \frac{107}{15,360} \tau^6 + \frac{107}{107,520} \tau^7 \right] \right. \\
&+ A^2 \left[ -\frac{11}{1280} \tau^2 + \frac{213}{256} \tau^3 + \frac{1}{6} \tau^4 - \frac{11}{10} \tau^5 - \frac{437}{640} \tau^6 - \frac{115}{768} \tau^7 \right] \\
&+ A^4 \left[ -\frac{1}{96} \tau^4 + \frac{25}{16} \tau^5 + \frac{187}{192} \tau^6 + \frac{7}{48} \tau^7 \right] + A^6 \left[ +\frac{169}{420} \tau^7 \right] \} C_3 \\
&+ \left\{ \left[ \frac{67}{384} \tau^2 - \frac{85}{1152} \tau^3 - \frac{1355}{2304} \tau^4 - \frac{325}{768} \tau^5 - \frac{1,129}{9,216} \tau^6 - \frac{1,129}{64,512} \tau^7 \right] \right. \\
&+ A^2 \left[ -\frac{395}{384} \tau^3 + \frac{1,595}{576} \tau^4 + \frac{263}{96} \tau^5 - \frac{121}{288} \tau^6 - \frac{365}{2,304} \tau^7 \right] \\
&+ A^4 \left[ -\frac{461}{96} \tau^5 + \frac{383}{144} \tau^6 + \frac{9,889}{4,032} \tau^7 \right] - A^6 \left[ \frac{3125}{1008} \tau^7 \right] \} C_5 \\
&+ \left\{ \left[ -\frac{7}{128} \tau^2 + \frac{77}{384} \tau^3 + \frac{161}{768} \tau^4 - \frac{413}{1280} \tau^5 - \frac{749}{3072} \tau^6 - \frac{107}{3072} \tau^7 \right] \right. \\
&+ A^2 \left[ \frac{7}{16} \tau^3 - \frac{469}{192} \tau^4 + \frac{49}{320} \tau^5 + \frac{1057}{288} \tau^6 + \frac{12,247}{11,520} \tau^7 \right] \\
&+ A^4 \left[ \frac{791}{240} \tau^5 - \frac{21}{4} \tau^6 - \frac{2303}{576} \tau^7 \right] + A^6 \left[ \frac{2401}{720} \tau^7 \right] \} C_7.
\end{aligned}$$

$$\begin{aligned}
\eta_8^* = & \{A[-\frac{643}{4608}\tau^2 - \frac{199}{1152}\tau^3 + \frac{65}{384}\tau^4 + \frac{179}{480}\tau^5 + \frac{917}{5760}\tau^6 + \frac{79}{3360}\tau^7 + \frac{11}{5760}\tau^8] \\
& + A^3[+\frac{1}{576}\tau^2 + \frac{1}{144}\tau^3 - \frac{1535}{2304}\tau^4 - \frac{16}{15}\tau^5 - \frac{1201}{1920}\tau^6 - \frac{169}{1120}\tau^7 - \frac{583}{20160}\tau^8] \\
& + A^5[\frac{1}{48}\tau^5 - \frac{329}{960}\tau^6 - \frac{1073}{2520}\tau^7 - \frac{803}{40320}\tau^8] + A^7[-\frac{43}{5040}\tau^8]\}C_2 \\
& + \{A[+\frac{269}{1440}\tau^2 - \frac{1079}{1440}\tau^3 - \frac{465}{256}\tau^4 - \frac{77}{120}\tau^5 + \frac{205}{576}\tau^6 + \frac{667}{2520}\tau^7 + \frac{1711}{40320}\tau^8] + \\
& A^3[-\frac{13}{720}\tau^3 + \frac{6925}{2304}\tau^4 - \frac{21}{80}\tau^5 - \frac{13001}{2880}\tau^6 - \frac{2897}{1260}\tau^7 - \frac{1411}{2880}\tau^8] \\
& + A^5[-\frac{1}{48}\tau^5 + \frac{433}{90}\tau^6 + \frac{73}{40}\tau^7 - \frac{1517}{8064}\tau^8] + A^7[\frac{13583}{10080}\tau^8]\}C_4 \\
& \{A[-\frac{197}{1536}\tau^2 + \frac{783}{640}\tau^3 + \frac{41}{768}\tau^4 - \frac{1609}{480}\tau^5 - \frac{3793}{1920}\tau^6 - \frac{1139}{3360}\tau^7 - \frac{3}{56}\tau^8] \\
& + A^3[-\frac{239}{64}\tau^4 + \frac{53}{6}\tau^5 + \frac{5399}{640}\tau^6 - \frac{731}{224}\tau^7 - \frac{8413}{6720}\tau^8] + A^5[-\frac{181}{15}\tau^6 + \frac{311}{42}\tau^7 + \frac{6877}{960}\tau^8] + A^7[-\frac{243}{35}\tau^8]\}C_6 \\
& + \{A[+\frac{1}{32}\tau^2 - \frac{1}{2}\tau^3 + \frac{15}{16}\tau^4 + \frac{223}{120}\tau^5 - \frac{129}{80}\tau^6 - \frac{117}{70}\tau^7 - \frac{39}{140}\tau^8] \\
& + A^3[\frac{25}{16}\tau^4 - \frac{863}{120}\tau^5 - \frac{11}{16}\tau^6 + \frac{32}{3}\tau^7 + \frac{617}{180}\tau^8] + A^5[\frac{229}{30}\tau^6 - \frac{343}{30}\tau^7 - \frac{416}{45}\tau^8] + A^7[\frac{2048}{315}\tau^8]\}C_8
\end{aligned}$$

$$\begin{aligned} \eta_9 = & \left\{ \left[ \frac{4343}{92160} \tau^2 + \frac{527}{18432} \tau^3 - \frac{911}{30720} \tau^4 + \frac{587}{92160} \tau^5 + \frac{9119}{276480} \tau^6 + \frac{1163}{92160} \tau^7 + \frac{119}{49152} \tau^8 - \frac{119}{442368} \tau^9 \right] \right. \\ & + A^2 \left[ -\frac{2683}{92160} \tau^2 + \frac{7019}{55296} \tau^3 + \frac{42437}{92160} \tau^4 + \frac{47263}{92160} \tau^5 + \frac{11143}{27648} \tau^6 + \frac{49331}{161280} \tau^7 + \frac{7759}{64512} \tau^8 + \frac{6629}{414720} \tau^9 \right] \\ & + A^4 \left[ -\frac{1}{1728} \tau^3 - \frac{109}{2560} \tau^4 + \frac{823}{7680} \tau^5 + \frac{4639}{17280} \tau^6 + \frac{1463}{11520} \tau^7 - \frac{841}{9216} \tau^8 - \frac{17693}{414720} \tau^9 \right] \\ & \left. + A^6 \left[ -\frac{7}{480} \tau^6 + \frac{677}{20160} \tau^7 - \frac{1171}{80640} \tau^8 + \frac{839}{241920} \tau^9 \right] + A^8 \left[ \frac{367}{45360} \tau^9 \right] \right\} C_1 \end{aligned}$$

$$\begin{aligned} & \{ A^0 \left[ \frac{867}{10240} \tau^2 + \frac{38819}{92160} \tau^3 + \frac{29}{64} \tau^4 + \frac{31}{384} \tau^5 - \frac{5417}{92160} \tau^6 - \frac{1709}{215040} \tau^7 + \frac{775}{172032} \tau^8 + \frac{775}{1548288} \tau^9 \right] \right. \\ & + A^2 \left[ \frac{439}{30720} \tau^2 - \frac{80963}{92160} \tau^3 - \frac{901}{1536} \tau^4 + \frac{31013}{15360} \tau^5 + \frac{252433}{92160} \tau^6 + \frac{81899}{71680} \tau^7 + \frac{15693}{71680} \tau^8 + \frac{9661}{387072} \tau^9 \right] \\ & + A^4 \left[ \frac{1}{576} \tau^3 + \frac{73}{1280} \tau^4 - \frac{7319}{2560} \tau^5 - \frac{20417}{5760} \tau^6 - \frac{167}{448} \tau^7 + \frac{1171}{3072} \tau^8 + \frac{73273}{967680} \tau^9 \right] \\ & \left. + A^6 \left[ \frac{23}{480} \tau^6 - \frac{1455}{896} \tau^7 - \frac{43711}{26880} \tau^8 - \frac{1909}{11520} \tau^9 \right] + A^8 \left[ -\frac{3839}{30240} \tau^9 \right] \right\} C_3 \end{aligned}$$

$$\begin{aligned} & + \{ A^0 \left[ -\frac{7079}{43008} \tau^2 - \frac{1687}{18432} \tau^3 + \frac{643}{768} \tau^4 + \frac{2821}{2304} \tau^5 + \frac{30457}{55296} \tau^6 + \frac{7093}{129024} \tau^7 - \frac{9703}{516096} \tau^8 - \frac{9703}{4644864} \tau^9 \right] \right. \\ & + A^2 \left[ -\frac{19}{43008} \tau^2 + \frac{72179}{55296} \tau^3 - \frac{32725}{9216} \tau^4 - \frac{6145}{768} \tau^5 - \frac{16325}{55296} \tau^6 + \frac{480559}{129024} \tau^7 + \frac{235453}{129024} \tau^8 + \frac{353911}{1161216} \tau^9 \right] \\ & + A^4 \left[ -\frac{197}{4608} \tau^4 + \frac{2959}{288} \tau^5 - \frac{43625}{13824} \tau^6 - \frac{24989}{1536} \tau^7 - \frac{404083}{64512} \tau^8 - \frac{72391}{64512} \tau^9 \right] \\ & \left. + A^6 \left[ -\frac{37}{864} \tau^6 + \frac{57763}{4032} \tau^7 + \frac{466551}{16128} \tau^8 - \frac{308449}{145152} \tau^9 \right] + A^8 \left[ \frac{37517}{9072} \tau^9 \right] \right\} C_5 \end{aligned}$$

$$\begin{aligned} & + \{ A^0 \left[ +\frac{453}{5120} \tau^2 - \frac{13951}{46080} \tau^3 - \frac{68033}{92160} \tau^4 + \frac{44611}{92160} \tau^5 + \frac{667807}{552960} \tau^6 + \frac{108943}{184320} \tau^7 + \frac{201023}{1474560} \tau^8 + \frac{201023}{13271040} \tau^9 \right] \right. \\ & + A^2 \left[ -\frac{24521}{27648} \tau^3 + \frac{30037}{5120} \tau^4 + \frac{30821}{23040} \tau^5 - \frac{1049377}{69120} \tau^6 - \frac{54799}{7680} \tau^7 + \frac{6853}{23040} \tau^8 + \frac{1771}{18432} \tau^9 \right] \\ & + A^4 \left[ -\frac{6293}{512} \tau^7 + \frac{156247}{5760} \tau^6 + \frac{58495}{2304} \tau^7 - \frac{327113}{23040} \tau^8 - \frac{2388887}{414720} \tau^9 \right] \\ & \left. + A^6 \left[ -\frac{21983}{720} \tau^7 + \frac{115903}{5760} \tau^8 + \frac{416959}{20736} \tau^9 \right] + A^8 \left[ -\frac{828543}{51840} \tau^9 \right] \right\} C_7 \end{aligned}$$

$$\begin{aligned} & + \{ A^0 \left[ -\frac{9}{512} \tau^2 + \frac{69}{512} \tau^3 + \frac{57}{2048} \tau^4 - \frac{6951}{10240} \tau^5 - \frac{2043}{20480} \tau^6 + \frac{10623}{20480} \tau^7 + \frac{7875}{32768} \tau^8 + \frac{875}{32768} \tau^9 \right] \right. \\ & + A^2 \left[ +\frac{15}{64} \tau^3 - \frac{645}{256} \tau^4 + \frac{4023}{1280} \tau^5 + \frac{23559}{2560} \tau^6 - \frac{204667}{35840} \tau^7 - \frac{19543}{2560} \tau^8 - \frac{102169}{71680} \tau^9 \right] \\ & + A^4 \left[ +\frac{15}{64} \tau^3 - \frac{645}{256} \tau^4 + \frac{3207}{640} \tau^5 - \frac{6501}{320} \tau^6 - \frac{36319}{8960} \tau^7 + \frac{119}{4} \tau^8 + \frac{52857}{5120} \tau^9 \right] \\ & \left. + A^6 \left[ +\frac{8017}{448} \tau^7 - \frac{128}{5} \tau^8 - \frac{13851}{640} \tau^9 \right] + A^8 \left[ \frac{59049}{4480} \tau^9 \right] \right\} C_9 \end{aligned}$$