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Abstract

Detailed analysis of a cold fuel droplet suddenly injected into a hot gas stream is examined. The effects of variable thermophysical properties, transient heating and internal circulation of liquid, deceleration of the flow due to the drag of the droplet, boundary-layer blowing, and moving interface are included. Several parametric studies are

boundary layer blowing, and moving meshes are included. Several parametric studies are performed by changing the following quantities: initial droplet temperature, ambient temperature, initial Reynolds number, fuel type, and droplet heating model. The results show that for higher transfer numbers, the vaporization rate is larger and the drag coefficient is significantly reduced mainly due to a large reduction in friction drag. For lower transfer numbers, the boundary-layer blowing effect is weaker and the drag coefficient is dominated by the Reynolds number only. The results also indicate that the constant-property calculation overestimates the drag coefficient.

Résumé

L'analyse détaillée d'une gouttelette de carburant froid est étudiée après l'injection dans un courant de gaz chaud. On considère les effets des propriétés variables, du chauffage variable et de la circulation interne du liquide, de la déviation de l'écoulement par la traînée de la gouttelette, du soufflage de la couche limite et de l'interface mobile. Plusieurs études paramétriques sont traitées en changeant les grandeurs suivantes: température initiale de la goutte, température ambiante, nombre de Reynolds initial, type de carburant et modèle de chauffage de la gouttelette. Les résultats montrent que pour des nombres élevés de transfert, la vitesse de vaporisation est grande et le coefficient de traînée est significativement réduit, principalement à cause de la forte réduction de la force de frottement. Pour des plus faibles nombres de transfert, l'effet du soufflage de la couche-limite est plus faible et le coefficient de traînée est dominé par le nombre de Reynolds.

Zusammenfassung

In der vorliegenden Arbeit werden die Vorgänge in einem kalten Kraftstofftröpfchen eingehend untersucht, das plötzlich in einen heißen Gasstrom injiziert wird. Dabei werden die Einflüsse variabler thermophysikalischer Stoffeigenschaften berücksichtigt, außerdem die transiente Wärmezufuhr und innere Zirkulation der Flüssigkeit, die Verzögerung der Strömung aufgrund des Tröpfchenwiderstandes, das Wegblasen der Grenzschicht und die bewegliche Grenzfläche. Folgende Parameter werden systematisch variiert: Anfangliche Tropfentemperatur, Umgebungstemperatur, anfängliche Reynolds-Zahl, Art des Kraftstoffs und Beheizungsmodell für das Tröpfchen. Die Ergebnisse zeigen, daß bei größeren Kennzahlen für den Wärmeübergang stärkere Verdunstung auftritt; der Widerstandsbeiwert wird signifikant kleiner, was im wesentlichen auf eine starke Verringerung der Reibung

zurA/4ckzutA/4hren ist. Bei kleinen Kennzahlen fA/4r den WAxrmeA/4bergang ist der Grenzschichteffekt geringer und der Widerstandsbeiwert wird allein von der Reynolds-Zahl beeinflusst. Die Ergebnisse zeigen auch, daß sich bei konstanten Stoffeigenschaften ein zu größerer Widerstandsbeiwert ergeben wÄ/4rde.

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Đ"AD½ Đ'eTAD»ÑCED½Ñ<Đ¹ AD,AD»Đ,Đ · Ñ†ApAD°TepĐ,cTĐ,Đ° Đ°AD½Đ»Đ,Đ½eĐ½AD³peToĐ³o ToĐ;Đ»Đ,Đ²A,Đ¼Đ³Đ½oĐ²eĐ½Đ,o Đ²Đ;ĐÑŽcĐ°Đ,Đ²AeĐ¼oĐ³o Đ²Đ;ĐoToĐ°Đ,AD³peToĐ³o Đ³AD·A. yÑ†Đ,TÑ<Đ²AÑŽTcÑ ÑÑ,,Ñ,,eĐ°TÑ<Đ,Đ ·Đ¼eĐ½ÑÑŽÑ%oĐ,Ñ†cÑ TeĐ;Đ»oÑ,,Đ,Đ ·Đ,Ñ†ecĐ°Đ,Ñ†cĐ²oĐ¹cTĐ²,Đ½ecTAN†Đ,oĐ½ApĐ½oĐ³o Đ½AD³peĐ²AĐ,Đ²Đ½yTpeĐ½Đ½eĐ¹Ñ†Đ,pĐ°yĐ»ÑÑ†Đ,Đ,Đ¶Đ,Đ 'Đ°ocTĐ,cĐ½Đ,Đ¶eĐ½Đ,ÑcĐ°opocTĐ,TeÑ†eĐ½Đ,ÑĐ ·AcÑ†eT coĐ;ĐpoTĐ,Đ²Đ»eĐ½Đ,ÑĐ°AD;Đ»Đ,Đ²Đ'yĐ²AĐ²Đ;ĐoĐ³pAD½Đ,Ñ†Đ½Ñ<Đ¹ cĐ»oĐ¹,ATAD°Đ¶eĐ'Đ²Đ,Đ¶yÑ%oeĐ¹cÑĐ³pAD½Đ,Ñ†Ñ<pAD·Đ'eĐ»A. ĐÿpoĐ²eĐ'eĐ½oĐ,ecĐ°oĐ»ÑCED°oĐ;ApAD¼eTpeĐ,Ñ†ecĐ°Đ,Ñ†Đ,ccĐ»eĐ 'oĐ²AD½Đ,Đ¹,Đ;ĐpĐ,Đ°oTopÑ<Ñ†Đ²ApÑCED,pod²AD»Đ,cÑCE TAD°Đ,e Đ²eĐ»Đ,Ñ†Đ½Đ½Ñ<,Đ°AD°Đ½AÑ†AD»ÑCED½AÑ TeĐ¼Đ;epATypA Đ°AD;Đ»Đ,TeĐ¼Đ;epATypA oĐ°pyĐ¶AÑŽÑ%oeĐ¹cpeĐ'Ñ<,Đ,cÑ†oĐ'Đ,oe Ñ†Đ,cĐ»o peĐ¹Đ½oĐ»ÑCED'cA,Đ²Đ,Đ'ToĐ;Đ»Đ,Đ²A,ATAD°Đ¶eĐ¼oĐ 'eĐ»ÑCEĐ½AD³peĐ²AĐ°AD;Đ»Đ,ĐÿoĐ»yÑ†eĐ½Đ½Ñ<e peĐ·yĐ»ÑCETATÑ<Đ;ĐoĐ°AD·Ñ<Đ²AÑŽT,Ñ†ToĐ;ĐpĐ,Đ²Ñ<coĐ°Đ,Ñ†Ñ†Đ,cĐ»AÑ†Đ;ĐepeĐ½ocAĐ,Đ½TeĐ½cĐ,Đ²Đ½ocTÑCEĐ,cĐ;ApeĐ½Đ,ÑĐ²oĐ ·pAcT AeTĐ,Đ°oÑÑ,,Ñ,,Đ,Ñ†Đ,eĐ½T coĐ;ĐpoTĐ,Đ²Đ»eĐ½Đ,ÑcyÑ%ocTĐ²eĐ½Đ½o yĐ¼eĐ½ÑCEÑ^AeTcÑĐ³Đ»AD²Đ½Ñ<Đ¼oĐ±pAD·oĐ¼Đ±Đ»AD³oĐ'ApÑĐ ·Đ,AÑ†Đ,TeĐ»ÑCED½oĐ¼y coĐ°pAÑ%oeĐ½Đ,ÑŽ coĐ;ĐpoTĐ,Đ²Đ»eĐ½Đ,ÑTpeĐ½Đ,Ñ. BcĐ»yÑ†AeĐ½Đ,Đ ·Đ°Đ,Ñ†Ñ†Đ,ceĐ»Đ;epeĐ½ocAĐ²Đ»Đ,ÑĐ½Đ,eĐ²Đ'yĐ²AĐ²Đ½oĐ³pAD½Đ,Ñ†Đ,Ñ<Đ¹cĐ»oĐ¹ÑĐ²Đ»ÑeTcÑĐ±oĐ»ee cĐ»AD±Ñ<Đ¼Đ,Đ°oÑÑ,,Ñ,,Đ,Ñ†Đ,eĐ½T coĐ;ĐpoTĐ,Đ²Đ»eĐ½Đ,ÑoĐ;ĐpeĐ'eĐ»ÑeTcÑÑ†Đ,cĐ»oĐ¼PeĐ¹Đ½oĐ»ÑCED'cA.



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